Architects' Technical Reference 1948

ARCHITECTS TECHNICAL REFERENCE

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THE TECHNICAL INFORMATION BOOK
of the ARCHITECTURAL ASSOCIATION

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FOREWORD

The *Architects' Technical Reference* was originally compiled by a Committee of leading members of the Architectural Association. Publication had to be suspended during the war years, and the present edition of this well-known reference book has been completely revised.

The Publishers will be most grateful to receive suggestions for material which might usefully be included in future editions.

Special acknowledgment is due to the following for their assistance in the revision of this edition : Mr. Edwin Gunn, A.R.I.B.A., Mr. Hope Bagenal, F.R.I.B.A., Professor Charles Spragge, and Mr. John Wilton, B.Sc., who has also undertaken the general work of preparation for the press.

Thanks are also due to the Controller of His Majesty's Stationery Office for permission to quote from numerous official publications ; to the Director of the British Standards Institution for permission to use extracts from British Standards ; and to the Directors of the Building Research Station and the Forest Products Research Laboratory for data and material supplied. Most valuable assistance has also been given by the Lighting Service Bureau, the British Electrical Development Association, the Aluminium, Copper, and Zinc Development Associations, and numerous other organisations and individuals.

ACOUSTIC DATA

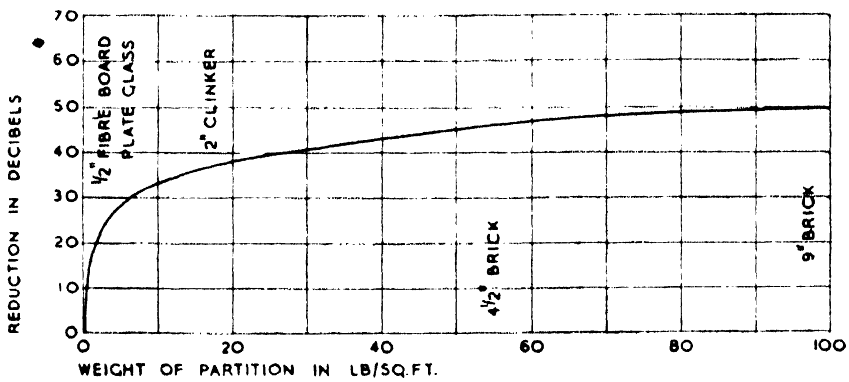
Contributed by H. Bagenal, F.R.I.B.A.

NOISE MEASUREMENTS

The British Scale of Equivalent Loudness is defined as follows :—" The equivalent loudness of a sound is *n* phons when it is judged, by a normal observer, to be of the same loudness as a 1,000-cycle plane progressive wave of which the sound intensity is *n* decibels above a zero corresponding to an acoustical pressure of 0·0002 dynes per square centimetre." For details see British Standard No. 661, " Glossary of Acoustical Terms and Definitions."
The following is a scale of ordinary noises in phons, selected from various authorities.

Rooms and Localities	Equivalent Loudness in Phons	Common Noises
	130	Threshold of Pain.
	120	Aeroplane Engine Testing Sheds.
Boiler Maker's Shop ...	110	
Noisy Tube Train ... Aeroplane Cabin ...	100	Pneumatic Drill, unsilenced. Noisy Sports Car and Motor Bike. Express Train at 12'.
Very noisy city street ...	90	Pneumatic Drill, " silenced." Motor Horns. Loud Music
	80	Trams. Accelerating 'Buses. Loud Radio Music.
Cinema Theatre ... Average City Street Noisy Office ...	70	Radio Speech. Average Music. Noisy Typewriters. Loud Public Speaking.
Room with ordinary conversation ... Quiet Street ... Train, windows closed	60	Normal Speaking Voice. Noisy Ball Tap Discharge.
Quiet Office... ... Quiet Restaurant ...	50	Quiet Saloon Car. Upper Limit of Household Noise.
Quiet Suburban Street ...	40	Low Radio Music.
Quiet Garden	30	Average Domestic Noise.
	20	Whispering.
	10	Rustle of leaves in slight breeze.
	0	Approximate Threshold of Audibility.

For sounds of moderate loudness and of middle pitch both decibel and phon represent the minimum increase of sound which the human ear can detect. An idea of the minimum reduction in loudness of a partition (in phons) is given approximately by the actual reduction in intensity measured for notes of medium pitch in decibels. The reduction factors of partitions are often tabulated as " average reduction in decibels."
For practical sound-proofing a change of 5 phons or 5 decibels, either an improvement or the reverse, can be taken as the minimum significant change.



TRANSMISSION THROUGH PARTITIONS

For single leaf homogeneous partitions of normal room-size the logarithm of the weight is the first measurement of comparative sound insulation. This is illustrated in the above graph. (It should be noted that for partitions larger than ordinary room size, in which diaphragm action may be increased, the sound reduction may be considerably less.) It will be seen that insulation by weight alone is, beyond a certain limit, uneconomical and for walls of ordinary dimensions double partitions without wall ties are often employed. It is desirable to keep the two leaves truly dissociated, by avoiding fragments of rubble in the air cavity, and if possible by insulating margins by means of cork or building blanket. A wider cavity than 2″ will increase efficiency, by further reducing air coupling. Equally important is the caulking of gaps, cracks, and junctions, and the sealing of interstices in the material itself. For this reason the ordinary coat of plaster is valuable. Other caulking materials are the quilts and building blankets. The Table below gives a list of approximate reduction factors for some ordinary walls and partitions taken from different sources. The figures refer to air-borne sounds only, under laboratory conditions, and take no account of impact sounds on the structure of the partition, nor of " flanking transmission " that is to say indirect transmission through adjoining portions of the structure. The figures, therefore, are an important contribution to design data but must always be used with a reference to the site conditions. The units given in the following table are units of sound reduction in decibels. That is to say if a noise at a certain frequency has a loudness equivalent to an intensity of 80 db. and is transmitted through a partition whose reduction factor is 45 db., the noise penetrating through that partition will have a loudness equivalent to an intensity of 80—45 = 35 db. In specifying against noise it is necessary to be quite clear as to whether walls are to defend against ordinary office noises such as typewriters and conversation, that is against sounds of loudness up to 60 phons ; or whether they must defend against sounds like radio music, gramophones, pianos, having loudness up to 80 or 90 phons and occurring against party walls or party partitions in residential buildings where tenants are trying to sleep. There is all the difference between these two sets of requirements : and partitions suitable for office buildings are not sound-proof enough for residential buildings.

APPROXIMATE REDUCTION FACTORS FOR PARTITIONS AND MEMBRANES

Name	Weight in lb./sq. ft.	Approximate Reduction Factor in db.
Cavity wall, 11" brick plastered, without rigid wall ties	80 to 100 lb.	55 db.
Solid poured concrete 9", faced both sides with 2-coat plasterwork on lath on battens fixed to concrete ...	not less than 80 lb.	55 db.
Single wall 9" brick plastered both faces	80 to 100 lb.	48 db.
Cavity wall, two 3" breeze block, plastered without wall ties, 2" cavity, edge insulation	45 to 50 lb.	50 db.
Timber stud partition, lath and plaster both sides, 4" 2" studs at 16" centres ...	20 lb.	40 to 50 db. varying with pitch
Single wall 4½ brick plastered	50 lb.	45 db.
Single 3" clinker block, unplastered	35 lb.	25 db.
Ditto, plastered both sides	37 lb.	44 db.
Single 2" to 2½" block wall, plastered ½" both sides ...	20 to 30 lb.	30 to 40 db. varying with weight
Fibre boards ½" on both sides of studs 16" centres plastered ½" thick	12 lb.	30 db.
Ditto unplastered	3 lb.	20 db.
Plate glass ¼" thick	3·5 lb.	30 db.
Window Glass	21 oz.	20 to 25 db. varying with pitch

Commenting on the above table it can be seen that weight and discontinuity are the governing factors. Light-weight boards and light-weight blocks with skim coatings, advertised as both heat and sound insulating generally tend to come low on the list for sound-insulation. Exceptions occur in the case of three coat plaster on wood lath on studs ; English tests and English experience give this a high place. Also a test on 1" thick woodwool slabs, plastered ½", on staggered studs, and having efficient edge insulation, has given a high figure. But stud partitions, and similar membrane structures, tend to resonance-transmission here and there on the frequency scale and are, therefore, less reliable for music-room insulation. In such cases fully discontinuous double structure is required. When such structure is also given a wide cavity and the cavity given a marginal absorbing lining, very high insulation figures are reached.

FLOORS

Where airborne noise is concerned floors tend to behave like partitions, weight being the important factor. The following table *for airborne sounds only* gives figures for ordinary timber construction. (This and the two following tables are taken from Post-War Building Study No. 14, " Sound Insulation and Acoustics," by permission of His Majesty's Stationery Office.)

Joist floor, plasterboard ceiling	35 db.
Joist floor, lath and plaster ceiling	45 db.
Ditto plus pugging 20 lb. per sq. ft.	50 db.
Joist floor, lath and plaster ceiling plus floating floor of boarding on battens, on quilt or building blanket, over whole area ...	55 db.

Where impact noise is concerned the sound tends to be caused by the whole floor structure, and the loudness of the sound will vary with the strength of the blow. For this reason the insulation values of various floor treatments against impact noise are given as a measure of improvement over a standard untreated structure. An untreated structure such as a bare pot or concrete floor generally gives no insulation against impact noises heard below it as compared to the same noises heard in the source room : the insulation of a bare timber joist floor may actually be a negative value where footsteps overhead are concerned. Taking a normal bare concrete floor, and an uncarpeted timber joist floor as zero value, the following Tables give the improvement in phons for various treatments.

AVERAGE INSULATION FOR IMPACT SOUND :

CONCRETE FLOORS

	Noise Reduction Phons
Bare concrete	0
Carpets, etc. :—	
⅛" lino, and ⅛" lino on roofing felt	5
Wood blocks, thin carpet, rubber ...	5–10
⅛" carpet on ⅛" underfelt; ¼" hard rubber-cork compo	10
$\frac{1}{16}$" sheet rubber on ¼" sponge rubber ...	20
Screeds, 2" thick, on following underlays :—	
Clinker	5–10
Granulated cork, 1"	10–15
Slag-wool quilt, or eelgrass quilt	15–20
Glass silk quilt, single layer, or eelgrass quilt, double layer	20
Glass silk quilt, double layer	25
Boarding on battens on following underlays :—	
Clips	5–10
Asbestos pads or felt pads, ½" thick ...	5–10
Fibreboard pads, ½" thick	10
Felt pads 1" thick, or rubber pads ½" thick	10–15
Eelgrass quilt, or slag-wool quilt, ½" thick	10–20
Glass silk quilt or rubber pads, 1" thick ...	15–20
Suspended ceilings :—	
¾" plaster on ½" fibreboard on 2" × 2" battens in clips	5–10
⅜" plaster on ⅜" plasterboard on battens in felt-lined clips	10–15

AVERAGE INSULATION FOR IMPACT SOUND : TIMBER FLOORS

Treatment	Noise Reduction Phons
Normal board and joist floor, lath and plaster ceiling	0
Carpet on underfelt	10
Plaster on plasterboard ceiling...	0
Pugging, sand, or ashes per sq. ft.	5
Sand or ashes 20 lb. per sq. ft.	10
Floor boards on cross battens on glass silk quilt, not nailed	5
Ditto on glass silk quilt, on sub-boarding ...	10
Ditto on fibreboard, on sub-boarding ...	5
Separate joists to carry ceiling	5

BACKGROUND NOISE AND MASKING LEVEL

There generally exists in a room a certain level of noise to which we have grown accustomed, spoken of as background noise. The degree of annoyance caused in a room by any new and unfamiliar noise is found to depend partly upon the level of the background noise, which masks it to a greater or lesser degree. Very roughly the new intruding noise to be noticeable must come within 15 or 20 db. of the background noise : if it is less it is scarcely of account. Thus an office having a background noise of 50 db. would not notice an intruding noise—say of traffic— unless it were at least 50 — 15 = 35 db. If, therefore, in such an office intruding noises of 80 db. are to be dealt with efficiently they must be reduced to at least 35 db. and will require a partition with a reduction factor of 80 — 35 d.b = 45 db.

The masking level of existing noises tolerated in a room for comfortable conditions are approximately as follows :—

Recording Studios for Speech	10–20 db.
" " " Music	20–25 db.
Hotels, flats, houses	20–30 db.
Hospitals	15–20 db.
Theatres, Churches, Schools	20–30 db.
Cinema Theatre	30–40 db.
Offices	30–40 db.

INSULATION STANDARDS FOR HOUSING

A summary of suggested noise insulation standards is given in Post-War Building Study No. 1 " House Construction " para. 92. They are as follows :—

Airborne Sound

(*a*) Between the living-room in one dwelling and the living and bedrooms in another, 55 db. reduction.

(*b*) Between the living-room and other rooms (except service rooms) in a dwelling, 45 db. reduction.

(*c*) Between other rooms (except service rooms), 35 db. reduction.

Impact Sound

Between any room in one dwelling and the living or bedrooms of the dwelling below, 15 phons reduction as compared with a bare concrete floor ; or 20 phons reduction as compared with a bare timber floor.

The above standards for airborne noise are very roughly equivalent to :—

(*a*) Cavity brick wall, 11″ thick, without wall ties, plastered.

(*b*) Brick wall 4½″ plastered.

(*c*) Single leaf 2½″ building block weight 30 lb. per sq. ft.

The " Housing Manual " of the Ministries, 1944, gives the following paras., p. 97 ; " It is desirable that the transmission of airborne noise be reduced to a minimum compatible with economy in construction. The sound reduction of party walls against airborne noise should be not less than 55 db. between living-rooms in one house and bedrooms and living-rooms in another. In the brick or block walled house this standard may be attained by the use of a cavity wall in 11″ brickwork or its equivalent in block or slab. Rigid wall ties should be avoided and the minimum number of wire ties, admissable from considerations of stability, should be used." Reference is also made to a solid poured concrete wall giving 55 db. reduction (see table above) and touching steel or reinforced concrete " it is not at present practicable to attain the required standard when the framework members are continuous between adjacent houses." The same standards for party walls apply to two-storey blocks of flats. "Also the sound reduction of floors separating flats in two-storey blocks should be not less than 55 db. for airborne noise, and not less than 5 phons improvement over a bare floor for impact noises." This standard for impact noises is considerably lower than the suggested standard in " House Construction," Post-War Building Study No. 1 (see above).

ROOM ACOUSTICS

Echo.—To avoid echo the excess path of a reflected sound element must not exceed the direct element by more than 60′ to 70′. Dangerous reflections tend to occur on plan as from rear wall remote from speaker, and from front side walls ; also on section from high ceilings, vaults, domes. Sound is reflected from a plane surface in such a way that the angle of reflection is equal to the angle of impact, and rays can be drawn out as from images of light in optics.

REVERBERATION TIMES

Reverberation is the duration measured in seconds of a sound of standard intensity after the source has ceased. The intensity is approximately 60 db. For good speech conditions the reverberation must be short and ought to be calculated in advance of construction by the Sabine formula to give approximately the following :—

Law Courts, Conference and Committee Rooms	1–1·5 seconds with one-third audience.
Parliament Houses, Council Chambers	1–1·6 seconds with quorum.
Halls and public auditories for the speaking voice	1·5–2 seconds with one-third audience, varying with volume
Concert Halls for Music only	1·6–2 seconds with full audience
Theatres and Cinema Theatres	1·3 seconds with two-thirds audience
Churches	2–3 seconds with one third congregation, varying with volume.

REVERBERATION FORMULA

Sabine's Formula for calculating reverberation is as follows :—

$$t = \frac{V}{A} \times 0{\cdot}05 \text{ for foot units}$$

$$t = \frac{V}{A} \times 0{\cdot}164 \text{ for metre units}$$

where t is the time of reverberation in seconds ; V is the volume of the room ; and A is the total absorbing power of the room described below.

Sabine's formula holds good for rooms containing a moderate amount of sound-absorbing material and for random reflections. For very dead rooms a closer approximation is given by Eyring's formula namely :—

$$t = \frac{V}{-S \log (1 - a)}$$

where S is the total absorbing surface area of the room and in the room, and a is the average coefficient of absorption for the surface of and in the room calculated by dividing the total absorption, including the audience factor, by the total surface area A.

In rough calculations for dead room of normal shape it is sufficient to make a correction for the Sabine formula by making a subtraction as follows :—

$$t = \frac{0{\cdot}05\,V}{A} - 0{\cdot}027\,\frac{V}{S}$$ where S is the total surface area in the room, and V the volume in cu. ft.

The total absorbing power of the room is arrived at by taking off the surface areas of the various materials, multiplying each area by its proper co-efficient of absorption, and adding up the products. Some absorbents are more readily expressed by a co-efficient per object, such as per person or per chair. The following classified lists are taken by permission from Post-War Building Study No. 14 before referred to. It must be remembered that coefficients vary as between one laboratory and another and vary also according to methods of fixing and decoration ; that is to say they are approximations only.

ABSORPTION COEFFICIENTS OF STANDARD BUILDING FINISHES

Materials	Absorption Coefficients		
	125 c.p.s.[1]	500 c.p.s.	4,000 c.p.s.
Open window, 1 sq. ft.	1·0	1·0	1·0
Group I			
Brickwork, unpainted	·024	·03	·05*
Brickwork, painted ...	·012	·017	·025*
Concrete or terrazzo	·01	·015	·02*
Polished stone or tiles	·01	·01	·015*
Plaster, gypsum, or lime (on brick)	·013	·025	·045*
Wood flooring (on battens)	·05	·03	·03*
Lino (on concrete) ...	·02*	·03	·05*

ABSORPTION COEFFICIENTS OF SPECIAL ABSORBENTS

Materials	125 c.p.s.	500 c.p.s.	4,000 c.p.s.
Group II			
Fibreboard tiles, perforated—½" thick on solid	·07	·57	·63
Fibreboard tiles, perforated—1¼" thick on solid	·13	·99	·5
Fibreboard, ½" on solid, not distempered ...	·05	·54	·6
Carpet	·09	·21	·37
Acoustic plaster (assumed on solid)	·13	·37	·58
Curtains:			
Light, 10 oz./sq. yd.	·04	·11	·3*
Heavy, 18 oz./sq. yd.	·10	·50	·90*
Felt, 1" thick	·10	·52	·44
Asbestos spray, 1" thick	·25*	·70	·60*

ABSORPTION CO-EFFICIENTS ON PANELS

Materials	Absorption Coefficients		
	125 c.p.s.	500 c.p.s.	4,000 c.p.s.
Group III			
3·5 mm. hardboard, 1 cm. airspace ...	·01	·17	·07
3.5 mm. hardboard, 3 cm. airspace ...	·12	·15	·15
3·5 mm. hardboard, 5 cm. airspace ...	·23	·15	·05
3 mm. plywood, 5 cm. airspace	·25	·20	·10
3 mm. plywood, 5 cm. airspace with 7 cm. wadding around edge of interspace ...	·42	·20	·13
3 mm. plywood with airspace filled with wadding	·70	·25	·13
Fibreboard tiles, 1¼" thick, 1" airspace behind	·28	·98	·49
Fibreboard, ½" thick, 3 cm. airspace, not distempered	·33	·27	·45
Acoustic plaster, ½", on ¾" backing, with 1" airspace behind ...	·29	·40	·60
Plaster on lath ...	·02	·03	·05
Glass	·035	·027	·02

*Figure deduced, and only approximate

[1] c.p.s. = cycles per second

COEFFICIENTS OF ABSORPTION FOR SEATS AND FOR MEMBERS OF AN AUDIENCE

Test figures for the above are difficult to arrive at and are not very consistent. It is suggested that the following figures be used for approximate calculations.

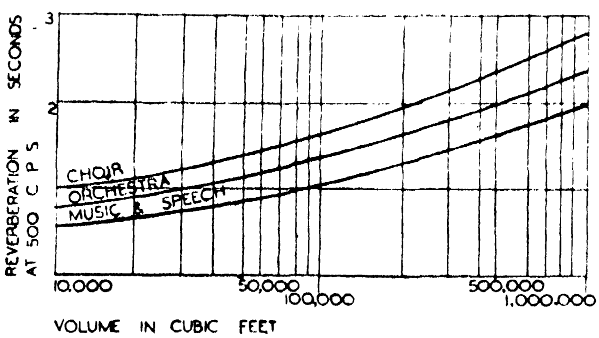
Absorbent	Absorption Coefficients		
	125 c.p.s.	500 c.p.s.	4,000 c.p.s.
Audience per person covering a seat ...	2·0	4·0	4·5
Seats : plywood and wood frame, per seat	0·15	0·17	0·38
Seats : theatre type ...	1·7	2·0	2·3
Seats : heavily upholstered, soft finish ...	2·8	3·0	3·6

ABSORPTION BY THE AIR

At frequencies above 2,000 cycles absorption by the air should be taken into account. This varies with the frequency and also with relative humidity. At 4,000 cycles, for normal room humidity, the air absorption can be expressed by a term m V where V is the volume in cu. ft. and m = 0·01. This amount should be added to the absorption of surfaces calculated by the ordinary formula, for that range of pitch.

DESIRABLE PERIODS OF REVERBERATION

These vary according to the size of the hall and to the requirements—whether speech, orchestral music, choral music. Desirable reverberation periods for middle pitch, as for the three generalised requirements, are given in the following graph. It will be seen that longer periods are preferred for concert halls where music is the chief requirement as compared to general purpose halls where both music and speech must be heard.



REVERBERATION FREQUENCY CURVES

Halls having good acoustics are found to have selective absorption as between treble, middle, and bass which gives a certain character to the reverberation frequency curve. There is generally found a certain smoothness, or lack of marked maxima and minima values, also a slight rise in the bass. Between 500 and 4,000 cycles approximately the curve is level. A rise in the upper frequencies is thought desirable, but in practice this is difficult owing to the greater normal absorption by ordinary surfaces of the upper frequencies, and owing to air absorption. The rise in the bass could probably be rather more for larger halls, and rather less, or even level, for smaller rooms where there is a danger of box resonance. Bass reverberation can be best controlled by panel absorbents, middle reverberation by thick mattressing and 'studio treatments' and the desirable reflection of upper frequencies can be had by the right proportion of glossy non-porous surfaces.

BOOKS OF REFERENCE

Fitzmaurice, R. and Allen, W. A. "Sound Transmission in Building." H.M.S.O., 1940.

Post-War Building Study, No. 14. "Sound Insulation and Acoustics." H.M.S.O., 1944.

Fleming and Allen. "Modern Theory and Practice in Building Acoustics." Jnl. Inst. of Civil Engineers. Structural Paper No. 12. March, 1945.

Bagenal H. "Practical Acoustics and Planning Against Noise." Methuen, 1942.

Glover, C. W. "Practical Acoustics for the Constructor." Chapman and Hall.

ADDRESSES

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82, New Cavendish Street, W.I. Langham 4041.
Georgian Group,
4, Hobart Place, S.W.I. Sloane 2844.
Housing Centre,
13, Suffolk Street, S.W.I. Whitehall 2881.
Incorporated Association of Architects and Surveyors,
75, Eaton Place, S.W.I. Sloane 3158.
Incorporated Clerks of Works Association of Great Britain,
5, Broughton Road, Thornton Heath, Surrey.
Institute of Builders,
48, Bedford Square, W.C.I. Museum 7197.
Institute of Chartered Accountants,
Moorgate Place, E.C.2. Monarch 2838.
Institute of Plumbers,
81, Gower Street, W.C.I. Museum 4518.
Institute of Registered Architects,
47, Victoria Street, S.W.I. Abbey 6172.
Institution of Civil Engineers,
Gt. George Street, S.W.I. Whitehall 4577.
Institution of Electrical Engineers,
Savoy Place, W.C.2. Temple Bar 7676.
Institution of Heating and Ventilating Engineers,
72, Victoria Street, W.C.I. Victoria 0146.
Institution of Landscape Architects,
12, Gower Street, W.C.I. Museum 1783.
Institution of Mechanical Engineers,
Storey's Gate, S.W.I. Whitehall 7476.
Institution of Municipal and County Engineers,
84, Eccleston Square, S.W.I. Victoria 5083.
Institution of Sanitary Engineers,
118, Victoria Street, Westminster, S.W.I. Victoria 3017.
Institution of Structural Engineers,
11, Upper Belgrave Street, S.W.I. Sloane 7128.
Land Agents' Society (Incorporated),
329, High Holborn. Chancery 8439.
Law Society,
110/113, Chancery Lane, W.C.2. Holborn 9446.
London Master Builders' Association,
47, Bedford Square, W.C.I. Museum 3767.
London Society,
British Museum, W.C.I. Museum 8196.
Mars Group,
46, Sheffield Terrace, W.8. Park 7678.
National Association of Local Government Officers,
24, Abingdon Street, S.W.I. Whitehall 9351.
National Buildings Record,
37, Onslow Gardens, S.W.7. Kensington 8161.
National Farmers Union,
45, Bedford Square, London, W.C.I. Museum 7535.
National Federation of Building Trade Employers,
82, New Cavendish Street, W.I. Langham 4041.
National Federation of Building Trade Operatives,
Rugby Street, W.C.I. Holborn 2770.
National Federation of Housing Societies,
13, Suffolk Street, S.W.I. Whitehall 2881.
National Trust,
42, Queen Anne's Gate, S.W.I. Whitehall 0211.
National Trust for Scotland,
4, Gt. Stuart Street, Edinburgh, 3.
Political and Economic Planning,
16, Queen Anne's Gate, S.W.I. Whitehall 7245.

Royal Geographical Society,
Kensington Gore, S.W.7. Kensington 5466.
Royal Incorporation of Architects in Scotland,
15, Rutland Square, Edinburgh.
Royal Institute of Architects of Ireland,
8, Marion Square, Dublin.
Royal Institute of British Architects,
66, Portland Place, W.1. Welbeck 5721.
Royal Institution of Chartered Surveyors,
12, Gt. George Street, S.W.1. Whitehall 5322.
Royal Sanitary Institute and Parkes Museum,
90, Buckingham Palace Road, S.W.1. Sloane 5134.
Royal Society of Arts,
6, John Adam Street, W.C.2. Temple Bar 8274.
Scapa Society,
71, Eccleston Square, S.W.1. Victoria 9274.
Society of Engineers,
17, Victoria Street, S.W.1. Abbey 7244.
Society of Incorporated Accountants and Auditors,
Victoria Embankment, W.C.2. Temple Bar 8822.
Society for the Protection of Ancient Buildings,
55, Gt. Ormond Street, W.C.1 Holborn 2646.
Town and Country Planning Association,
28, King Street, W.C.2. Temple Bar 5006.
Town Planning Institute,
18, Ashley Place, S.W.1. Victoria 8815.

RESEARCH BOARDS AND ASSOCIATIONS

British Cast Iron Research Association,
Alvechurch, Birmingham. Redditch 716.
British Non-Ferrous Metals Research Association,
Euston Street, N.W.1. Euston 3372.
Building Research Station,
Bucknalls Lane, Garston, Watford. Garston 2246.
Forest Products Research Laboratory,
Princes Risborough, Bucks.
Fuel Research Station,
Blackwall Lane, S.E.10.
Geological Survey of Great Britain,
Exhibition Road, S.W.7.
National Physical Laboratory,
Teddington, Middlesex. Molesey 1380.
Research Association of British Paint, Colour and Varnish Manufacturers,
Waldegrave Road, Teddington, Middlesex. Molesey 1063.
Road Research Laboratory,
Harmondsworth, Middlesex.
Rubber Research Association,
105, Lansdowne Road, Croydon. Croydon 6105.
Water Pollution Research Laboratory,
Langley Road, Watford, Herts. Watford 4477.

TRADE ASSOCIATIONS AND INFORMATION BUREAUX

Aluminium Development Association,
67, Brook Street, W.1. Mayfair 7501.
British Cast Concrete Federation,
17, Amherst Road, W.13. Perrivale 6869.
British Electrical Development Association,
2, Savoy Hill, W.C.2. Temple Bar 9434.
British Door Association,
25, Victoria Street, S.W.1. Abbey 5422.
British Ironfounders Association,
145, Vincent Street, Glasgow, C.2. Central 2891.
British Plastics Federation,
47, Piccadilly, W.1.
British Steelwork Association,
Buckingham Gate, S.W.1. Victoria 7301.
Cement and Concrete Association,
52, Grosvenor Gardens, S.W.1. Sloane 5255.
Copper Development Association,
Grand Buildings, Trafalgar Square, W.C.2.
English Joinery Manufacturers' Association,
40, Piccadilly, W.1. Regent 4448.
Lead Industries Development Council,
Eagle House, Jermyn Street, W.1. Whitehall 7264.
Natural Asphalte Mineowners and Manufacturers Council,
94, Petty France, S.W.1. Abbey 1010.
Reinforced Concrete Association,
91, Petty France, S.W.1. Whitehall 9936.
Timber Development Association,
75, Cannon Street, E.C.4. City 6147.
Zinc Development Association,
Lincoln House, Turl Street, Oxford. Oxford 47988.

LONDON AUTHORITIES

London County Council,
County Hall, Westminster Bridge, S.E.1. Waterloo 5000.
District Surveyors : see page 10.
London Passenger Transport Board,
55, Broadway, S.W.1. Abbey 1234.
London and Home Counties Joint Electricity Authority,
5, Millbank, S.W.1.
Port of London Authority,
Trinity Square, E.C.3. Royal 2000.
Metropolitan Water Board,
Rosebery Avenue, E.C.1. Terminus 3300.
Thames Conservancy,
Norfolk Street, W.C.2. Temple Bar 5855.
City of London Corporation,
Guildhall, E.C.2. Clerkenwell 2011.
City of Westminster,
City Hall, W.C.2. Temple Bar 0111.

METROPOLITAN BOROUGH COUNCILS

Battersea,
Municipal Buildings, Lavender Hill, S.W.11. Battersea 2200.
Bermondsey,
Spa Road, S.E.16. Bermondsey 2441.
Bethnal Green,
Town Hall, Cambridge Heath Road, E.2. Advance 4831.
Camberwell,
Town Hall, Peckham Road, S.E.5. Rodney 2081.
Chelsea,
Town Hall, King's Road, S.W.3. Flaxman 4804.
Deptford,
Town Hall, S.E.14. Tideway 1288.
Finsbury,
Town Hall, Rosebery Avenue, E.C.1. Terminus 2121.
Fulham,
Town Hall, Fulham, S.W.6. Fulham 4465.
Greenwich,
Town Hall, Greenwich High Road, S.E.10. Greenwich 2561
Hackney,
Town Hall, Mare Street, E.8. Amherst 4412.

Hammersmith,
Town Hall, King Street, W.6. Riverside 6011.
Hampstead,
Town Hall, Haverstock Hill, N.W.3. Primrose 4421.
Holborn,
Town Hall, High Holborn, W.C.1. Holborn 2692.
Islington,
Town Hall, Upper Street, N.1. Cannonbury 3388.
Kensington (Royal Borough)
Town Hall, Kensington, W.8. Western 7211.
Lambeth,
Town Hall, Brixton Hill, S.W.2. Brixton 4901.
Lewisham,
Town Hall, Catford, S.E.6. Hither Green 4622.
Paddington,
Town Hall, Harrow Road, W.2. Paddington 5086.
Poplar,
Town Hall, Bow Road, E.3. Advance 4414.
St. Marylebone,
Town Hall, Marylebone Road, N.W.1. Welbeck 7766.
St. Pancras,
Town Hall, Euston Road, N.W.1. Terminus 7070.
Shoreditch,
Town Hall, Old Street, E.C.1. Bishopsgate 3311.
Southwark,
Town Hall, Walworth Road, S.E.17., Rodney 3825.
Stepney,
London Fruit Exchange, Duval Street, E.1. Bishopsgate 6500.
Stoke Newington,
Town Hall, Church Street, N.16. Clissold 7003.
Wandsworth,
Municipal Buildings, S.W.18. Battersea 6464.
Woolwich,
Town Hall, Woolwich, S.E.18. Woolwich 1121.

DISTRICT SURVEYORS UNDER THE LONDON BUILDING ACTS AMENDMENT ACT, 1939

The District Surveyors are statutory officers appointed under sections 75 *et seq.*, of this Act, and it is their duty to see that the provisions of the London Building Acts and the byelaws thereunder are complied with. They are paid by fees, which in nearly every case are payable by the building owner. The amounts of the fees are prescribed in the Act.

Notice of any work must be given two clear days before the work is begun.

The office hours are 9.30 to 5 ; Saturdays, 9.30 to 1.
Personal attendance 9.30 to 10.30 daily.

Battersea.—E. D. McDowall, 160, Lavender Hill, S.W.11. Battersea 4218.
Bermondsey.—A. C. Meston, 185, Tower Bridge Road, S.E.1. Hop 0558.
Bethnal Green.—F. L. Felgate, 1, Montfort House, Victoria Park Square, E.2. Advance 3437.
Camberwell North.—T. S. Hosking, 5, Windsor Walk, S.E.5. Tel. Rodney 2120.
Camberwell South.—S. G. Skrimshire, 5, Windsor Walk, S.E.5. Rodney 3560.
Chelsea.—G. M. Hall, 4, Sydney Street, S.W.3. Flaxman 2115.
City of London, East.—A. E. Mayhew, 26, Martin Lane, E.C.4. Mansion House 9976.
City of London, West—A. E. Mayhew, 107, Fleet Street, E.C.4. Central 4622.
Deptford.—T. P. Tinslay, 329 New Cross Road, S.E.14. Tideway 2370.
Finsbury.—C. C. Knowles, 58, Myddelton Square, E.C.1. Terminus 1332.
Fulham.—A. L. Handley, Broadway House, Broadway, S. W.6. Fulham 2390.
Greenwich.—T. P. Tinslay, 34, Crooms Hill, S.E.10. Greenwich 0155.
Hackney, East.—H. R. Chanter, 222, Mare Street, E.8. Amherst 4302.
Hackney, West.—W. G. Whincop, 133, Stoke Newington High Street, N.16. Clissold 7685.
Hammersmith.—J. H. Whittaker, 227–9 Hammersmith Road, W.6. Riverside 5304.
Hampstead.—D. Whyte, 279E, Finchley Road, N.W.3. Hampstead 4867.
Holborn.—F. P. Scott, 3, Verulam Buildings, Grays Inn, W. C. 1. Chancery 7785.
Islington, East.—F. G. Pearson, 407, Holloway Road, N.7. North 2909.
Islington, West.—J. I. Padget, 407, Holloway Road, N.7. North 1561.
Kensington, North.—Percy S. Dixon, 76, Westbourne Grove, W.2. Bayswater 6971.
Kensington, South.—G. M. Hall, 113, Earl's Court Road, S.W.5. Frobisher 4739.
Lambeth, North.—F. P. Watson, 69, Kennington Oval, S.E.11. Reliance 2185.
Lambeth, South.—T. S. Hosking, 5, Windsor Walk, S.E.5. Rodney, 2120.
Lewisham, East and West.—T. R. L. Gibson, 7, Catford Road, S.E.6. Hither Green, 1817.
Paddington.—R. R. S. Dean, 76, Westbourne Grove, W.2. Bayswater 6968.
Poplar.—S. J. Nunn, 86, Bow Road, E.3. Advance 2124.
St. Marylebone, East and West.—John Dovaston, 14, Bryanston Street, W.1. Welbeck 5866.
St. Pancras, North.—H. E. Watkinson, 240, Kentish Town Road, N.W.5. Gulliver 1626.
St. Pancras, South.—D. D. J. Clarke, 14, Percy Street, W.C.1. Museum 1867.
Shoreditch.—P. T. Dean, 124, Shoreditch High Street, E.1. Bishopsgate 4208.
Southwark —E. P. Featherstone, 14–16 New Kent Road, S.E.1. Rodney 3393.
Stepney, East.—E. J. Fisher, 1, West Arbour Street, E.1. Stepney Green 3223.
Stepney, West.—F. W. C. Barker, 29, Toynbee Street, E.1. Bishopsgate 5280.
Stoke Newington.—W. G. Whincop, 133, High Street, N.16. Clissold 7685.
Wandsworth, East and West.—R. H. King, 5–9, Mitcham Road S.W.17. Balham 2766.
Wandsworth, North.—I. D. Walker, 188, Clapham High Street, S.W.4. Macaulay 1880.
Westminster, South and East.—L. A. D. Shiner, 25, Cockspur Street, S.W.1. Whitehall 9986.
Westminster, West.—A. Lane, 25, Cockspur Street, S.W.1. Abbey 3735.
Woolwich, North.—R. C. Griffiths, 21, Calderwood Street, S.E.18. Woolwich 1364.
Woolwich, South.—R. C. Griffiths, 6, Passey Place, S.E.9 Eltham 2255.

MINISTRY OF WORKS

REGIONAL ORGANISATION

Where no separate address is stated the offices of the Ministry's Regional Licensing Officers, Regional Disposals Officers, Regional Materials Officers, and Regional Works Control Centres are the same as for the Regional Director for the Region concerned.

Region 1—NORTHERN
Cumberland, Durham, Northumberland, Westmorland and N. Riding of Yorkshire.
The Regional Director, Government Buildings, Gosforth, Newcastle-on-Tyne. Gosforth 53931.
Regional Licensing Officer, 2, Sydenham Terrace, Newcastle-on-Tyne. Newcastle 23574.
Regional Disposals Officer (as for Region 2).

Region 2—EAST AND WEST RIDINGS
East and West Ridings of Yorkshire.
The Regional Director, Government Buildings, Lawnswood, Leeds, 6. Leeds 74411.
Regional Licensing Officer, 93a, Albion Street, Leeds. Leeds 27311.

Region 3—NORTH MIDLANDS
Derby (except High Peak), Leicester, Lincoln, Northampton, Nottingham, Rutland.
The Regional Director, Government Buildings, Lenton, Nottingham. Nottingham 77733.

Region 4—EASTERN
Bedford, Cambridge, Isle of Ely, Huntingdon, Norfolk, Suffolk, Essex (part).
The Regional Director, Shaftesbury Road, Brooklands Avenue, Cambridge. Cambridge 55206.

Region 5—LONDON
London, Middlesex, S.W. Essex, W. Kent, Surrey, Hertford, S.E. Buckingham.
The Regional Director, 8, Cornwall Terrace, Regents Park, N.W.1. MUSeum 5030.
Regional Licensing Officer, 17, Cornwall Terrace, Regents Park, N.W.1. MUSeum 5030.
Regional Disposals Officer, Onslow Gardens, London, S.W.7. KENsington 7070.
Regional Materials Officer, 51–54, Gracechurch Street, London, E.C.3. MANsion Ho. 9855.

Region 6—SOUTHERN
Berkshire, Buckingham (outside Region 5), Dorset, Hampshire, Isle of Wight, Oxford.
The Regional Director, Whiteknights Road, Earley, Reading. Reading 61431.

Region 7—SOUTH WESTERN
Cornwall, Devon, Goucester, Wiltshire.
The Regional Director, 5, Priory Road, Bristol. Bristol 38493.
Regional Licensing Officer, 5–6, Cotham Lawn Road, Bristol, 6. Bristol 36841.
Regional Disposals Officer, 33–35, Oakfield Road, Bristol. Bristol 38231.
Regional Materials Officer, 23, Richmond Hill, Clifton, Bristol. Bristol 38457.
Regional Works Control Centre (as for Disposals Officer).

Region 8—WALES
Wales and Monmouth.
The Regional Director, Park Place, Cardiff. Cardiff 9017, 9070.

Region 9—MIDLAND
Hereford, Shropshire, Stafford, Warwick, Worcester.

The Regional Director, 37, Temple Street, Birmingham. Midland 6561.
Regional Materials Officer, Phoenix Chambers, Colmore Row, Birmingham. Central 1901.
Regional Works Control Centre, Viceroy Close, Bristol Road, Birmingham. Calthorpe 3151.

Region 10—NORTH WESTERN
Cheshire, Lancashire, Derby (High Peak District).
The Regional Director, 76, Newton Street, Manchester. Central 2191.
Regional Licensing Officer, 80, Princess Street, Manchester. Central 6931.
Regional Works Control Centre, Hudsons Buildings, Great Ancoates Street, Manchester. Central 2191.

Region 11—SCOTLAND
The whole of Scotland.
The Under-Secretary of State, 122, George Street, Edinburgh. Edinburgh 23053.
Regional Licensing Officer, 9, George Street, Edinburgh. Edinburgh 34621.

Region 12—SOUTH EASTERN
Sussex, Kent (except W.)
The Regional Director, Forest Road, Tunbridge Wells, Tun. Wells 2780.
Regional Disposals Officer, 33, Boyne Park, Tunbridge Wells. Tun. Wells 3102.
Regional Materials Officer, 2, Frant Road, Tunbridge Wells. Tun. Wells 3470.

MINISTRY OF TOWN AND COUNTRY PLANNING

REGIONAL ORGANISATION

Each of the following offices is in the charge of a Regional Controller, to whom all correspondence should be addressed. The geographical boundaries of the Regions are as for the Ministry of Works, as stated above.

Region 1—NORTHERN
12, Sydenham Terrace, Newcastle-on-Tyne, 2. Newcastle 28307–8

Region 2—EAST AND WEST RIDINGS
Hopewell House, 173, Woodhouse Lane, Leeds, 2. Leeds 30837.

Region 3—NORTH MIDLAND
2, Lucknow Drive, Mapperley Park, Nottingham. Nottingham 66064–5.

Region 4—EASTERN
Shaftesbury Road, Brooklands Avenue, Cambridge. Cambridge 55947–8.

Region 5—LONDON
19, St. James's Square, London, S.W.1. WHitehall 8411.

Region 6—SOUTHERN
19, Bath Road, Reading, Berks. Reading 60826.

Region 7—SOUTH WESTERN
3–5 Woodland Road, Bristol, 8. Bristol 36801.

Region 8—WALES
66, Park Place, Cardiff. Cardiff 8470–1.

Region 9—MIDLAND
1, Norfolk Road, Edgbaston, Birmingham, 15. Edgbaston 3624–5.

Region 10—NORTH WESTERN
100, Palatine Road, West Didsbury, Manchester. Didsbury 3937.

Region 12—SOUTH EASTERN
24, Calverley Park, Tunbridge Wells, Kent. Tunbridge Wells 3237.

ARTIFICIAL LIGHTING

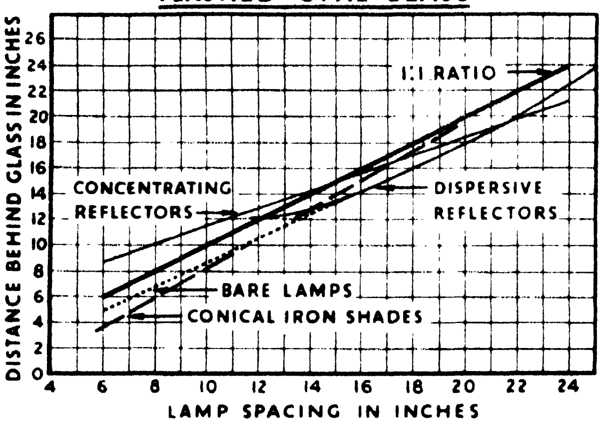
(Compiled by The Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.)

TRANSLUCENT FITTINGS

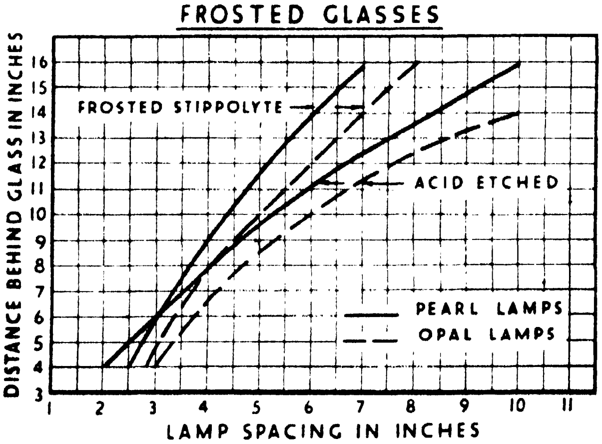
LAMP SPACING

The relation between lamp spacing and distance of light source from the glass surface to provide approximately even brightness is shown on the diagrams below.

FLASHED OPAL GLASS



FROSTED GLASSES



The spacing of lamps indicated on these curves represents the maximum permissible spacing which can be used in connection with the particular glass at a given distance of the lamp centre from the glass itself. Spacing is independent of lamp size, which will affect the brightness of the luminous area but not its uniformity. The curves shown assume the lamps to be installed in a white-lined enclosure.

EXAMPLE

If flashed opal glass and pearl lamps are used, and the available space behind the glass only permits the lamp centres to be installed at a maximum distance of 6″ behind the glass the lamps should not be spaced at a greater distance apart than 8½″.

On the other hand, if the lamps are installed unnecessarily far from the glass, the efficiency of the system is impaired. For example, in one test with opal glass used in a flush panel, the minimum distance of lamp centre from the glass to avoid spottiness was found to be 7″. Increasing this distance to 10″ resulted in a reduction of luminous efficiency by some 6 per cent.

Tubular fluorescent lamps may be installed in parallel lines at 50 per cent greater spacing between lines than with tungsten filament lamps ; but where they are required to be placed end to end the gap between the lighted sections of adjacent lamps is likely to be apparent unless :—

(*a*) Lamps are slightly overlapped, or

(*b*) the distance of the lamp centre behind the glass is at least 3″ plus a further inch for every inch distance between the luminous parts of consecutive lamps, or

(*c*) a grille is used to conceal the dark patches.

A grille, if used, should be shaped to cover also the first inch of each lamp to conceal the normal end blackening of lamps towards the end of life.

BRIGHTNESS VALUES DESIRABLE

The average brightness of a 14″ 200-watt spherical enclosed fitting of opal glass is about 1¼ or 1½ candles per sq. in. The desirable brightness of a luminous feature must be settled by the architect or designer, but it is unlikely that brightnesses greater than the above would be acceptable where medium or large luminous areas are concerned, particularly if they are placed at or near eye level. Small luminous areas well outside the normal line of vision, and placed against a background of reasonable brightness might have a brightness of up to perhaps 5 candles per sq. in. without causing discomfort.

TRANSMISSION FACTORS

The transmission factors of various types of glass and plastics are given below.

	Per cent
Clear glass	80–90
Glass (acid etched)	62–87
Glass (clear configurated)	67–87
"Perspex" (opal)	20–60
Flashed opal glass	30–60
Pot opal glass...	12–40
White plastic (opaque)	0–60

Note.—The above figures must not be taken to represent the lighting efficiency of complete fittings made from translucent materials. An enclosed spherical fitting made of flashed opal glass (which, say, transmits 60 per cent, reflects 25 per cent and absorbs 15 per cent of the light) will eventually emit about 80 per cent of the original lamp light, the apparent gain being due to repeated internal reflections.

LUMEN RATING AND DIMENSIONS OF STANDARD LAMPS (PEARL AND CLEAR)

Watts	Type	Dimensions		Light Centre Length m/m.	Standard Cap.	Minimum Average Lumens throughout Life		
		Length m/m.	Diameter m/m.			At 110v.	At 230v.	
						Single Coil	Single Coil	Coiled Coil
15	Pearl	92.5	55	65	B.C.	133	113	—
25	,,	100	60	70	,,	228	206	—
40	,,	110	60	80	,,	449	330	389
60	,,	117.5	65	85	,,	759	584	665
75	,,	125	70	90	,,	1,000	785	883
100	,,	137.5	75	100	,,	1,400	1,160	1,270
150	,,	160	80	120	,,	2,230	1,970	—
200	Clear	178	90	133	E.S.	3,090	2,725	—
300	,,	233	110	178	G.E.S.	4,950	4,430	—
500	,,	267	130	202	,,	8,950	7,930	—
750	,,	300	150	225	,,	14,270	12,740	—
1,000	,,	300	150	225	,,	19,640	17,800	—
1,500	,,	335	170	250	,,	30,220	28,380	—

LUMINOUS RATING AND DIMENSIONS OF FLUORESCENT LAMPS

Watts	Shape	Length	Dia.	Average Lumens Throughout Life	Cap
40 W.	Tubular daylight	4 ft.	1½ in.	1720	Bi-pin each end
80 W.	Tubular daylight	5 ft.	1½ in.	3040	B.C. each end
40 W.	Tubular warm white	4 ft.	1½ in.	1720	Bi-pin each end
80 W.	Tubular warm white	5 ft.	1½ in.	3040	B.C. each end

Note.—An extended range of tubular fluorescent lamps (200–250 v. A.C.), will include the following, in both " daylight " and " warm white " colours. Bi-pin caps will be fitted.

Wattage		Length ft.		Diameter ins.
30	...	3	...	1
20*	...	2	...	1½
20	...	2	...	1
15*	...	1½	...	1

*Also suitable for operation on 100–130 v. A.C. Mains, or two in series (i.e., 2–20 watt or 2–15-watt) on 200–250 v. A.C. Mains.

TUBULAR LAMPS

The tubular lamp, on account of its small cross section, provides a light source which is particularly useful in architectural lighting where space for lighting equipment is so often limited. Tubular lamps are or will be available in both double and single-cap forms, the latter being frequently employed as luminous elements in modern lighting fittings based on the candelabra design. The use of " Architectural Lamps " permits a continuous line of light to be obtained, which can often be incorporated as a decorative feature.

Filament type tubular lamps may be replaced in installations where the runs are long by fluorescent tubes of four or five foot length, with a large increase in efficiency ; an installation of say 1,000 watts of filament tubular lamps replaced by a similar wattage of fluorescent tubes would have increased illumination to the order of 400 per cent.

ARCHITECTURAL LAMPS

The lamps concerned are all in round tube of 30 mm. diameter, with standard peg caps 38 mm. from the ends of the tube. Other details to the nearest inch are as follows :—

Straight Lenths

Length in.				Nominal watts
12*	...	...	...	35
24	...	...	...	75
36	...	...	...	110
48	...	...	...	150

Curves

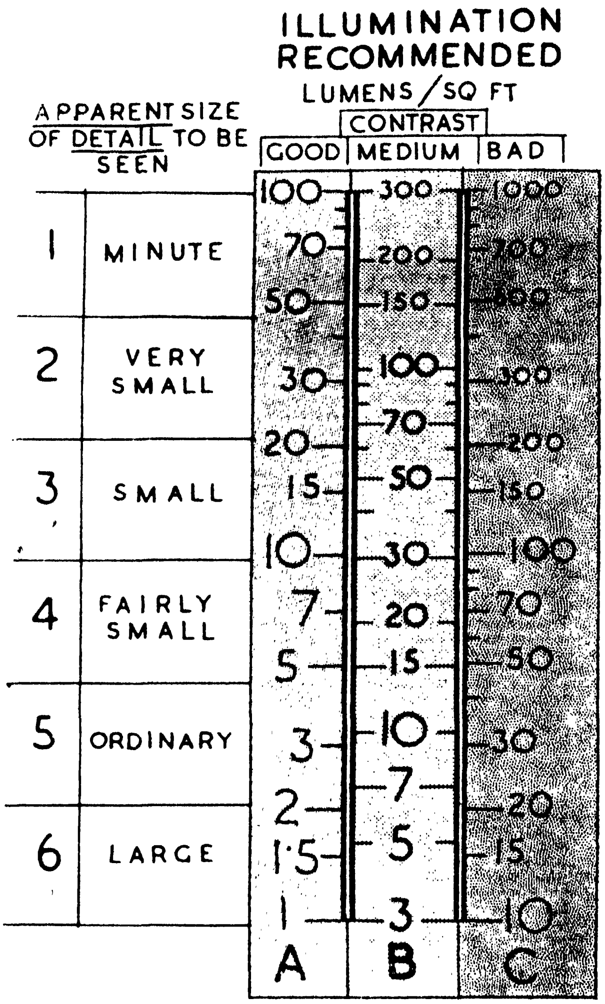
Shape	Radius in.	Nominal watts
½ circle	6¼	60
¼-circle*	12½	60
⅛-circle*	25	60

All are for 200–260 volts, and those marked * also for 100–130 volts. Bulb finish is clear or white opal, or sprayed white, red, blue, green, or amber.

RECOMMENDED VALUES OF ILLUMINATION

The recommended values of illumination have been obtained from theoretical and practical consideration of lighting requirements, and are in line with good modern practice.

The following diagram gives a method of assessing the illumination required :—



If the reflection factor of the detail to be seen differs widely from that of its immediate background, use Scale A. If it differs moderately, use Scale B. If it differs little, use Scale C. Scale B represents average conditions, and is, therefore, shown in heavy type. General lighting is recommended for values shown in large type.

General or (general plus local) lighting is recommended for values shown in medium type.

Local supplementing general lighting is recommended for values shown in small type.

If the table headed " Illumination Recommended for Adequate Seeing Conditions " (see below) does not list the particular task in question or an apparently similar one the above chart should be used to determine the illumination required.

First decide what is the apparent size of detail to be seen (this depends both on the actual size of critical detail, and on viewing distance). Opposite the appropriate " size " scale will be found ranges of illumination depending on whether the contrast of the object with its immediate background is good (Scale A), medium (B), or bad (C).

Thus, for instance, the illumination required on a book in a reading room, the detail to be seen, i.e., the print, is small (3) the contrast is good (A), i.e., black print on white paper. Therefore the illumination should fall in grade 3A between about 10–20 lumen foot² (f.c.) the actual value recommended being 15 lumen foot.²

ILLUMINATION RECOMMENDED FOR ADEQUATE SEEING CONDITIONS

The recommended values of illumination given below are service values of average illumination and agree with those published by the Illuminating Engineering Society.

VALUES OF ILLUMINATION

	Lumens ft^2 or f.c.	Grade	
ART STUDIO			Special lighting
AUTOMOBILE SHOW ROOM ...		4B	Special lighting
CHURCH			
Church	7	5B	
Church Hall	7	5B	
CINEMA			Special lighting
CORRIDORS AND STAIRWAYS ...	3	6B	
DANCE HALL			Special lighting
DENTIST			
Waiting Room...	7	5B	
Surgery (Operating Area)	70	2B	
DRAWING OFFICE			
Boards	30	4B	
General...	10	5B	
GARAGE			
Garage	7	5B	
Garage Repair Department ...	20	4B	
GYMNASIUM	10	5B	Special lighting for Games
HOSPITAL			
Wards and Private Rooms	3	6B	
Waiting and Receiving Room ...	7	6B	
Operating Table	300	1B/C	Special lighting
Operating Room	30	4B	
Laboratories	20	4B	
HOTEL			
Lounge and Dining-Room	7	5B	Often special lighting
Writing Room			
General	7	5B	
Tables		4B	Special lighting
Kitchen	7	5B	
Bedrooms	5	6B	Bed-head lights, etc., also required
INDOOR RECREATIONS			
Bowling (on Alley, Runway and Seats)	15	5B	
(on Pins)	20	4B	Special lighting
Billiards (General)	3	6B	
(on Table)	20	4B	
Racquets, Badminton, Squash and Indoor Tennis		4B	Special lighting
Skating Rinks	7	6B	
LIBRARY			
Reading Rooms (General Lighting)	7	4A	
Reading Rooms (on Books) ...	15	3A	
Book Room	7	4A	
MARKET	10	5B	
MUSEUM	7	5B	Extra lighting for showcases
OFFICES AND BANKS			
General Office Work	20	4B	
Private Office	15	3A	
Typing and Book-keeping	20	4B	
Filing	20	4B	
PUBLIC HALL	7	5B	Sometimes special lighting
REFRESHMENT ROOM	7	5B	
RESTAURANT	7	5B	
SCHOOL			
Day Class Rooms	15	4B	
Drawing and Art	20	4B	
Gymnasiums	10	5B	
Laboratories	15	4B	
Lecture Theatre	10	5B	
Sewing	20	4B	
SHOPS			
Interiors	10 and upwards		
Display Windows	100 and upwards		
TELEPHONE EXCHANGE	7	5B	
THEATRE...			Special lighting
TOILET AND WASHROOM ...	7	6B	
WAITING-ROOM	7	6B	

SPECIAL LIGHTING RECOMMENDATIONS

Illumination at working level (L/ft.^{2})	Brightness of fittings (candles per sq. in.)	Miscellaneous
OFFICES		
All offices	Desirable maximum 5 (measured over appreciable areas) at all angles below the horizontal with sufficient upward light to give bright ceiling.	Lighting points at distance from windows to be separately switched. Decorations and furniture light coloured and non-glossy.
HOSPITALS		
Wards (local lighting)—	Of the order of 1 for general ward lighting. Local lighting fittings substantially opaque, with maximum brightness 1 as seen from any other bed.	Decorations light coloured, matt where feasible. Illumination below 0.1 L/ft.^{2} for all-night lighting in wards, 5 L/ft.^{2} in night nurses' room and part of ward reserved for her use.
SHOPS		
Places where persons are employed—6 (min.) Bulk storage and corridors (floor level)—2 (min.) On vertical surfaces at top of storage shelves 1	Visible parts of general lighting fittings 10 (max.), or use fittings with cut-off at least 20° below horizontal	Very important to instal lighting scheme with best possible appearance.
DOMESTIC		
—	Desirable maximum 2 at any angle from horizontal to 30° below (for general lighting)	Generous provision for portable lighting to enable living rooms to be used for any likely purpose.
HOTELS AND RESTAURANTS		
Bars (vicinity of)—6 (min.) Corridors and stairways 1½ during day and evening, up to level of all floors to which public have access Exterior lighting for car parks and yards	For interior general lighting 5 (max. measured over appreciable areas) at any angle below the horizontal	Bedrooms — minimum of 3 lighting points: (*a*) General (also possibly to serve mirror) (*b*) Bed (*c*) Wash basin
SCHOOLS		
15- with higher values for backward or myopic children	In classrooms— From horizontal to 30° below—of the order of 1 From 30° below horizontal to downward vertical—5 (max.)	Decorations light coloured and non-glossy. Chalkboards with similar reflection factor to wall on which they are mounted. Special lighting for chalkboard probably necessary (vertical illumination equal to horizontal illumination on desks). Photocell controlled switching is desirable, at least for rows of lights furthest from windows.
CHURCHES AND CHAPELS		
Lighting of Sanctuary and Altar as Chancel, but mainly on vertical surfaces	Maximum 10 at all angles greater than 60° from downward vertical, for parts of fittings normally visible to persons other than the preacher	—
PUBLIC BUILDINGS—*General*		
Exteriors, about 1 immediately outside entrances and exits used by public	—	Interior decorations light coloured and non-glossy where feasible
Public Halls		
7 (min.) with provision for suitable values for all purposes for which hall may be used	Unlimited from downward vertical to 30° below horizontal Above this no visible part of a fitting to be greater than 10	Pilot or emergency lighting for films, etc. Direct lighting should only be used in conjunction with other systems

Illumination at working level ($L/ft.^2$)	Brightness of fittings (candles per sq. in.)	Miscellaneous
Public Libraries and Reading Rooms		
On backs of books (vertical plane)—2 (min.)	Maximum 5 as seen from any normal position	Illumination on walls, etc., to which reading matter is affixed 15 $L/ft.^2$ on vertical and inclined surfaces
Market Halls		
—	If under 16 ft. above floor, and within 100 ft. of observer, maximum 10 ; or cut-off at least 20 deg. below horizontal	Local lighting fittings of dense or opaque material or installed so as to prevent glare to all persons
Public Baths		
Swimming baths — at promenade floor level over area of water, promenade and cubicles—general 7 Slipper baths—general 7	—	For design purposes consider cubicles occupy unobstructed area, but sufficient lighting points are necessary to prevent undue shadows. Consider decorative and safety value of under-water lighting
Picture Galleries and Museums		
Picture Galleries—probably of the order of 7 on vertical picture walls Museums — general — 7 (min.) for safety and maintenance. Additional general, localised, or local lighting according to nature of exhibition	Owing to the great difficulties in avoiding unwanted reflections, each interior of this nature should be given individual attention by a specialist in this class of work. Owing to the many special problems which arise, each interior of this nature should be given individual attention by a specialist in this class of work.	
Courts of Law		
In Well of Court and at important points (Bench, Witness Box, etc.)—15 Corridors, stairways and public parts 3 (min.)	Unlimited from downward vertical to 30° below horizontal. Above this no visible part of fitting to be greater than 10	—

EFFECT OF ROOM PROPORTIONS AND DECORATIONS

The light reaching the working plane from the majority of general lighting installations is partly received by reflection from secondary surfaces such as walls and ceilings. Since these surfaces always absorb some of the light striking them, the total amount of useful light received must depend to some extent on the proportion of lamp light which strikes them, which in turn will depend on the distribution of light from the fitting and the proportions of the room.

Any type of fitting having a direct component of light, and mounted by itself near the ceiling of a short, narrow, lofty room will obviously shed a greater proportion of the total lamp light on the walls and ceiling, than if a number of such fittings were mounted low in a very long and wide room. Thus, the lighting system tends to become less efficient as the ratio of the mounting height to length and breadth of rooms are increased, and this fact must be taken into account.

The colour of the ceiling and general decorations will have a considerable effect on the illumination received, especially in indirect and semi-direct installations in which the greater part of the useful light is received by reflection from these surfaces. The combined result of the Room Index and the reflectivity of the surroundings gives the Coefficient of Utilisation. (See Handbook No. 2, "Interior Lighting Design" issued by the Lighting Service Bureau.)

TEMPERATURE RISE AND RADIATED HEAT

The amount of energy which is radiated as light output from the 100-watt filament lamp is approximately 10 per cent of the input energy, whilst the remainder is converted into heat and dissipated by the lamp as radiation approximately 73 per cent, heat gas convections approximately 12 per cent, heat to supports and leads approximately 5 per cent.

For an equivalent light output fluorescent lighting would generate ½ to 1/3 of the heat and the radiation would be in the order of 1/5 to ¼. Thus a temperature rise will be caused in any confined space ; in a specific case the temperature rise in a cabinet using 400 watts of tubular lamps was 22° F. This would have been serious if the cabinet had contained sweets or confectionery. The same standard of illumination was obtained in this cabinet by using one 80-watt fluorescent lamp and the temperature rise was only 5°F.

Temperature rise caused by radiation from electric lamps is not generally a serious problem. For example, a wooden door jamb of dimensions 6′ × 9″ × 5″ was glazed on the front and side surfaces with opal glass and equipped with ten 25-watt pearl lamps. Two tests were carried out, one unventilated (totally enclosed) and the other ventilated (open back). The maximum temperature was 53°C. and 39·5°C. respectively (steady temperatures after one hour's operation). As the ignition temperature of dry pinewood is 427°C. and the smoking temperature about 150°C. it is reasonable to assume that wood-lined troughs can be safely used for decorative lighting features. It is nevertheless important to arrange for adequate clearance between the lamp bulb and any combustible surface to avoid local heating and also to prevent possible blackening of the bulb ; it is suggested that a minimum figure of 2″ is satisfactory for lamps up to 100 watts size. It must also be remembered that adequate allowance should be made for the safe expansion of glass and other surfaces.

REFLECTION FACTORS OF VARIOUS SURFACES

It has already been stated that reflection from walls and ceilings plays an important part in lighting. Reflection factors for various surfaces and colours are given below.

Material	Per Cent Reflection Factor
Good Mirrors, Prisms	90
Best white surfaces	85
White tile, glossy	80
Portland stone	62
Light stone	58
Middle stone	37
Dark stone	33
Concrete unpainted	45
Clean yellow brick	35
Clean red brick	25
White pine	61
Poplar	47
Plain deal	45
Red oak	32
Silvered glass	86
Aluminium paint	72
Stainless steel and chromium plate	60
Nickel	47
Cast iron, bright	28
Cast iron, dull	12
Galvanised iron or steel, unpainted	16
White paint, glossy	78
Plaster (Keene's cement finish)	75
Plaster board	60
Ivory, glossy	69
Ivory, matt	64
Paint, Eau de Nil	47
Paint, French Grey	36
Paint, Light Battleship Grey	31
Paint, Dark Battleship Grey	11
Paint, Post Office Red	17

COMPUTED VALUES OF ILLUMINATION

Area per Fitting Sq. ft.	Size of Lamp Watts	Coefficient of Utilisation											
		·10	·15	·18	·20	·23	·26	·30	·35	·40	·45	·50	·55
		Lumens/ft.^{2} (f.c.)											
36	80F	6·8	10·1	12·2	13·5	15·6	17·6	20·3	23·6	—	—	—	—
	150	—	6·6	8·0	8·8	10·0	11·5	13·3	15·5	17·5	20·0	22·0	24·0
	200	6·0	9·0	11·0	12·0	14·0	16·0	18·5	21·5	24·5	—	—	—
	2 × 80F	12·2	18·2	21·9	24·3	—	—	—	—	—	—	—	—
	300	10·0	15·0	18·0	20·0	23·0	26·0	—	—	—	—	—	—
72	80F	—	—	6·1	6·8	7.8	8.8	10·1	11·8	13·5	15·2	16·9	18·6
	150	—	—	—	—	—	—	6·5	7·5	9·0	10·0	11·0	12·0
	200	—	—	—	6·0	7·0	8·0	9·0	10·5	12·0	14·0	15·5	17·0
	2 × 80F	6·1	9·1	10·9	12·3	13·9	15·8	18·2	21·2	24·3	—	—	—
	300	—	7·5	9·0	10·0	11·5	13·0	15·0	17·5	20·0	22·5	25·0	—
	500	9·0	13·5	16·0	18·0	20·5	23·0	—	—	—	—	—	—
108	80F	—	—	—	—	—	—	6·8	7·9	9·0	10·1	11·3	12·5
	150	—	—	—	—	—	—	—	—	6·0	6·5	7·5	8·0
	200	—	—	—	—	—	—	6·0	7·0	8·0	9·5	10·5	11·5
	2 × 80F	—	6·1	7·3	8·1	9·3	10·5	12·2	14·2	16·2	18·2	21·1	22·2
	300	—	—	6·0	6·5	7·5	8·5	10·0	11·5	13·5	14·5	16·0	17·5
	500	10·0	9·0	10·5	11·5	13·5	15·5	18·0	20·8	23·5	26·5	—	—
144	80F	—	—	—	—	—	—	—	—	6.8	7·6	8·4	9·3
	150	—	—	—	—	—	—	—	—	—	—	—	6·0
	200	—	—	—	—	—	—	—	—	6·0	7·0	8·0	8·5
	2 × 80F	—	—	—	6·1	7·0	7·9	9·1	10.6	12·3	13·7	15·2	16·7
	300	—	—	—	—	—	6·5	7·5.	8·5	10·0	11·0	12·5	13·5
	500	—	6·5	8·0	9·0	10·0	11·5	13·5	15·5	18·0	20·0	22·5	24·5

F=Fluorescent

ASBESTOS BUILDING SHEETS

See B.S. 690 : 1945

PLAIN SHEETS

When used on walls these sheets may be fixed to battens or studs not more than 24″ apart, with cross rails to take the horizontal joints. The sheets are butt-jointed and nailed ½″ from the edge with flat-headed galvanised or copper nails. Where the sheets are not papered over or otherwise covered, it is desirable to cover the joints with strips. These sheets may be fixed to ceiling joists which are spaced as above described. They may also be fixed to steel sections with galvanised cup-headed bolts. The following thicknesses are recommended :—

For ceilings ... ... 5/32″ (up to 4′ × 4′)
For internal linings and partitions 3/16″ to ¼″
For external work ... ... ¼″ to ⅜″

STANDARD SIZES OF FLAT SHEETS

Length	Width	Thicknesses
8′ 0″	4′ 0″	5/32″ 3/16″ ¼″ 5/16″ ⅜″
7′ 0″	4′ 0″	5/32″ 3/16″ ¼″
6′ 0″	4′ 0″	
6′ 0″	5′ 0″	
4′ 0″	4′ 0″	

The weights of flat sheets are as follows :—

Thickness :	⅛″	5/32″	3/16″	¼″	⅜″	½″
Wt. per sq. yd. :	7	8¾	10½	14	21	28 lb. (approx).

CORRUGATED SHEETS

On roofs these may be fixed to wood or steel purlins, and on walls to wood or steel rails. They are fixed to wood with 3″ × ¼″ galvanised iron screws with cupped washers, and to steel work with ¼″ diameter hook bolts with cupped washers or with clips. In roofing work it is desirable to space the purlins at not more than 3′ centres, but on walls the rails may be spaced up to 4′ 6″ apart.

Lengths ... Sizes increase by 6″ from a minimum length of 4′ up to 10′.
Widths ... 30″ and 41½″ usual. (See B.S.)
Thickness ... 7/32″ and ¼″

End Lap—6″ : Side Lap—1 or 2 corrugations.
Ordinary corrugations are approximately 3″ centres.
" Big-six "-type corrugations are approximately 6″ centres.
Trafford tiles are flat sheets ribbed at intervals of 13″–15″.
Turn-layer types have corrugated sheet sandwiched between two flat sheets.
Butt-jointed double cladding—as used on " Arcon " houses—consists of channelled sheets breaking joint as fixed.
Weight : The inclusive weight of corrugated sheeting, etc. fixed is about 32 lb. per sq. yd.

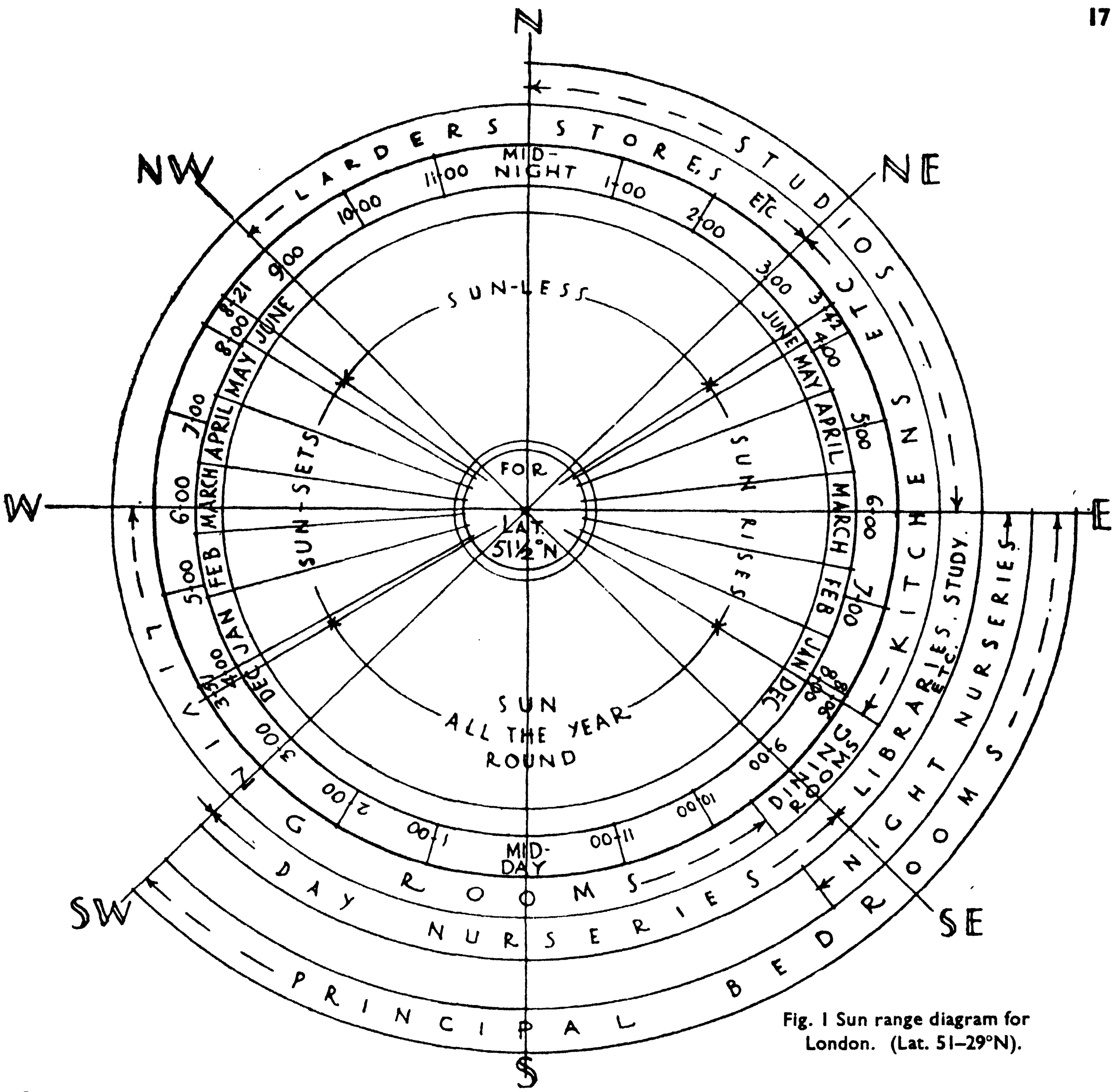


Fig. I Sun range diagram for London. (Lat. 51–29°N).

ASPECT

In figure I above is shown the range of sunshine in the latitude of London. It indicates the times and directions of sunrise and sunset during each month of the year, the aspects where sunshine is directly available at any time during each day throughout the year, and the orientations and times at which no sun is available. On the outer perimeter the ideal aspects are shown for various rooms. Figure 2 shows the altitudes of the sun on a north-south aspect during the months of the year. The diagram may be used for the spacing of buildings and of parts of buildings and for the determination of relative heights in regard to sunshine. It is particularly useful when considering sloping sites, tall buildings (such as flats or hotels), and courtyard dimensions.

References :

"The Lighting of Buildings," Post-War Building Studies, No. 12, 1944. H.M.S.O., 2s. 6d.

British Standard Code of Practice. CP.5. "Sunlight," B.S.I., 1945., 6d.

"The Orientation of Buildings," R.I.B.A., 5s. 0d.

R.I.B.A. Science Lectures (Journal) for values of block distribution.

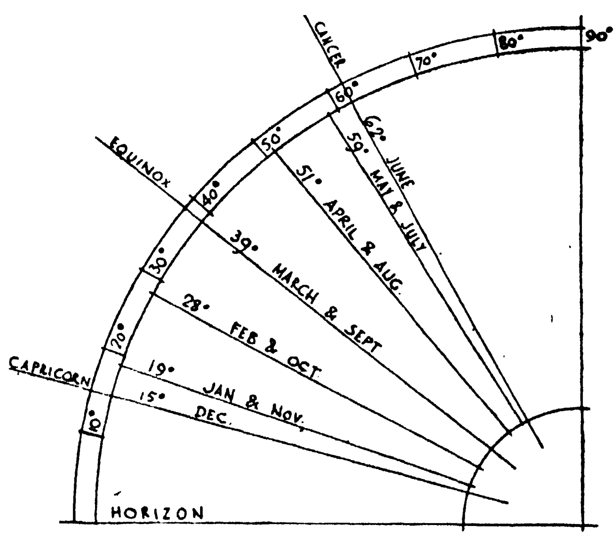


Fig. 2. Sun altitudes for London on N.S. aspect.

ASPHALT

Asphalt may be defined as a natural or mechanical mixture in which asphaltic bitumen is associated with an appreciable proportion of inert mineral matter.
The term includes a number of natural and manufactured products.
Mastic Asphalt, is a mechanical mixture of natural asphalt rock (or other suitable aggregate) with asphaltic bitumen, in such proportion as to give a substantially voidless, and impermeable mass with plastic properties, which can be laid by hand while in a hot semi-fluid condition.

See B.S. 1076 : 1942, 1093 : 1944 and 1177 : 1944 for Flooring.
B.S. 988 : 1941 and 1162 : 1944 for Roofing.
B.S. 1097 : 1943 for asphalt damp-proof courses and tanking.

For more detailed information in regard to the nature of raw materials used, methods of manufacture and questions of application etc., reference should be made to Building Research Special Report No. 25, "The Use of Asphalt Mastic for Roofing." H.M.S.O., 9d.
A precis of this Report, containing recommendations, can be obtained on application to the Natural Asphalte Mine-Owners and Manufacturers Council, 94, Petty France, S.W.1.

ROOFING.

FALLS

Roofs which are to be kept free of standing water should be specified to have a fall of 1 in 80 (1½″ in 10′ 0″) which should be provided in the screed or by firring.
Roofs which are to be used as reservoirs should be provided with falls to facilitate periodic draining.

KEYS FOR ASPHALT

Before asphalt is applied to brick walls, all joints should be carefully raked out at least ½″ to provide a key. Concrete walls or sloping surfaces should be adequately grooved or hacked to provide a key for the first coat of asphalt.

SUB-STRUCTURE

Asphalt should not be laid direct upon coke breeze or pumice concrete. Such materials should be covered with a cement screed and a felt underlay.

UNDERLAYS

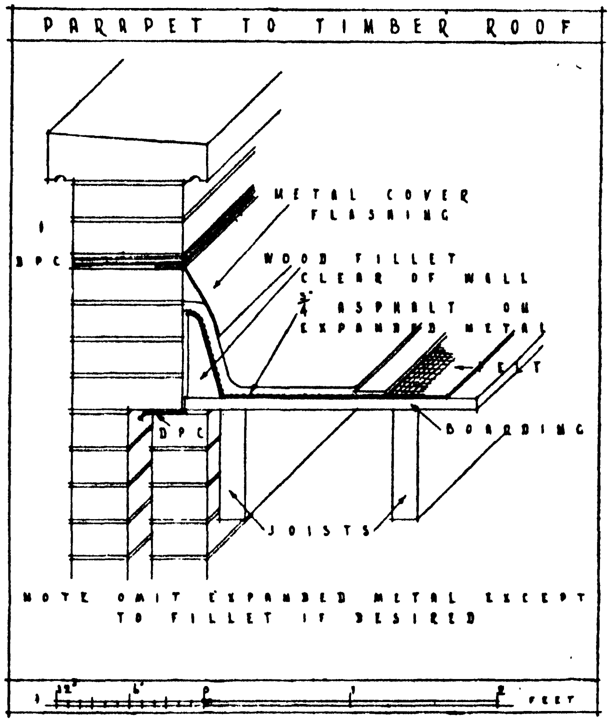
Asphalt to be laid direct over flat concrete roofs (as distinct from application over an insulating medium) should have an underlay of impregnated felt, which should be applied loose with lapped joints and not affixed to the concrete by an adhesive. Where an insulating material is placed over the concrete it is essential that an impregnated felt underlay, with lapped joints, should be utilised under the asphalt.

SKIRTINGS

Against walls, curbs, parapets, etc. (where not carried up or over same) an asphalt skirting at least 6″ high should be provided with a strong asphalt fillet in the internal angle.
A horizontal chase should be formed to receive the nib of the skirting and to provide a key into which the asphalt is turned. The joint between the wall and the asphalt skirting should afterwards be pointed.
Where flashings are employed, they should be turned down over asphalt skirting, normally to a depth of 3″. A clearance should be provided between the asphalt and the metal to prevent capillary attraction.

PARAPETS

There is some doubt of the efficiency of the cement rendering sometimes applied to the back of a solid parapet wall, owing to the possibility of the formation of cracks, and a tendency for the rendering to shrink away at the junction with the asphalt skirting, thus permitting damp penetration. A protective cover of asphalt in two layers is not subject to such cracking or shrinkage, and provides a permanent weather protection which can be run in continuity with the D.P.C. under the coping.



TIMBER ROOFS

A felt underlay laid loose must be provided under asphalt on timber roofs. An asphalt skirting on a wood roof should be supported for its full height upon a wood fillet fixed to the roof and standing free from the wall. This prevents movement between the timbers and the wall being transferred to the asphalt. A necessary adjunct to this fillet is a lead or copper flashing, supported in the top joint of the first clear course of brickwork above the skirting.
The use of wire mesh or expanded metal is not essential on horizontal work, but on slopes and also at angles formed by sloping or vertical timber surfaces, expanded metal lathing must be employed to reinforce the asphalt and provide a support.

SURFACE FINISH

The asphalt contractor should be informed of the nature of the traffic or load to which a roof is to be subjected, since these factors have to be taken into account in considering the appropriate grade of materials and in agreeing any particular form of construction.

THICKNESS AND NUMBER OF COATS

(a) Asphalt to be laid on horizontal concrete should be specified to be applied in two coats, breaking joint, to a total thickness of not less than ¾″ on and including an underlay of impregnated felt applied loose with lapped joints and laid to falls previously prepared in the foundation.

(*b*) On vertical concrete surfaces or slopes of more than 1 in 10 (other than skirtings, risers, etc.) asphalt should be applied in three coats, breaking joint to a finished thickness of not less than ¾", such surfaces having previously been prepared to receive the asphalt by adequate grooving or hacking.

(*c*) Asphalt laid horizontally on wood boarding should be specified to be applied in two coats, breaking joint, to a total thickness of not less than ¾" on and including an underlay of impregnated felt laid loose, and laid to falls previously prepared by firring.

(*d*) Horizontal asphalt lining for permanent water storage on roofs, should be specified to be of 1⅛" asphalt applied in three coats, breaking joint on and including an underlay of impregnated felt laid loose, with a three coat vertical lining and two coat angle fillets.

DAMP-PROOFING

Asphalt as an ordinary horizontal damp-proof course, above ground level or, through a parapet wall, may be applied in one ½" coat. It should be kept back ½" from the face of the brickwork to allow for pointing.

Below ground level (except in work which comes under the category of "tanking" see below), both horizontal and vertical work should be in two layers, the former of a thickness of ¾" and the latter not less than ½", all internal angles having an asphalt fillet.

TANKING

By "tanking" is meant a continuous asphalt lining to a basement, or reservoir, or swimming bath, for the purpose of waterproofing as distinct from dampcoursing.

The asphalt must be applied in three coats, with broken joints, with a two coat asphalt fillet at all internal angles. Horizontal work is laid to a total thickness of 1⅛" and vertical work should be not less than ¾".

ILLUSTRATED EXAMPLES

Some of the principal uses of asphalt are shown in diagram form on the following pages :—

Fig. 1.—Waterproofing a simple basement, showing unprotected asphalt applied to outer face of wall where subsequent damage by digging is unlikely. Also an alternative method where asphalt is applied to a skin wall from within, before the main wall is built.

Figs. 2 and 3.—A method of underpinning and waterproofing a sub-basement on a town site, showing asphalt kept within the structure. A method of sealing under a stanchion base is also indicated.

Fig. 4.—A method of underpinning and waterproofing a sub-basement on a town site, showing asphalt applied outside the structural work.

Fig. 5.—A method of water-proofing the roof of a vault under a pavement, including the treatment round a pavement light.

Fig. 6.—Typical roof details of a steel-framed building where asphalt is desired as a covering to the sloping surfaces and dormers. For convenience, only one storey is shown above the cornice. There are, of course, other satisfactory methods of dealing with insulation, key for asphalt and window treatment.

Fig. 7.—Flat roofs in wood and concrete. It is usually considered advisable to insert lead or copper at the junction of the roof with the gutter in the manner shown, i.e., the metal being placed under the full thickness of the asphalt. The treatment at the sill of the roof-light shown (with metal flashing), is preferred by some specialists to that shown for concrete construction.

Fig. 8.—Simple cases showing positions of dampcourses, equally applicable to other materials.

Reference :

Asphalt in Building Construction, Roofs and Basements (Natural Asphalte Mine-Owners and Manufacturers Council).

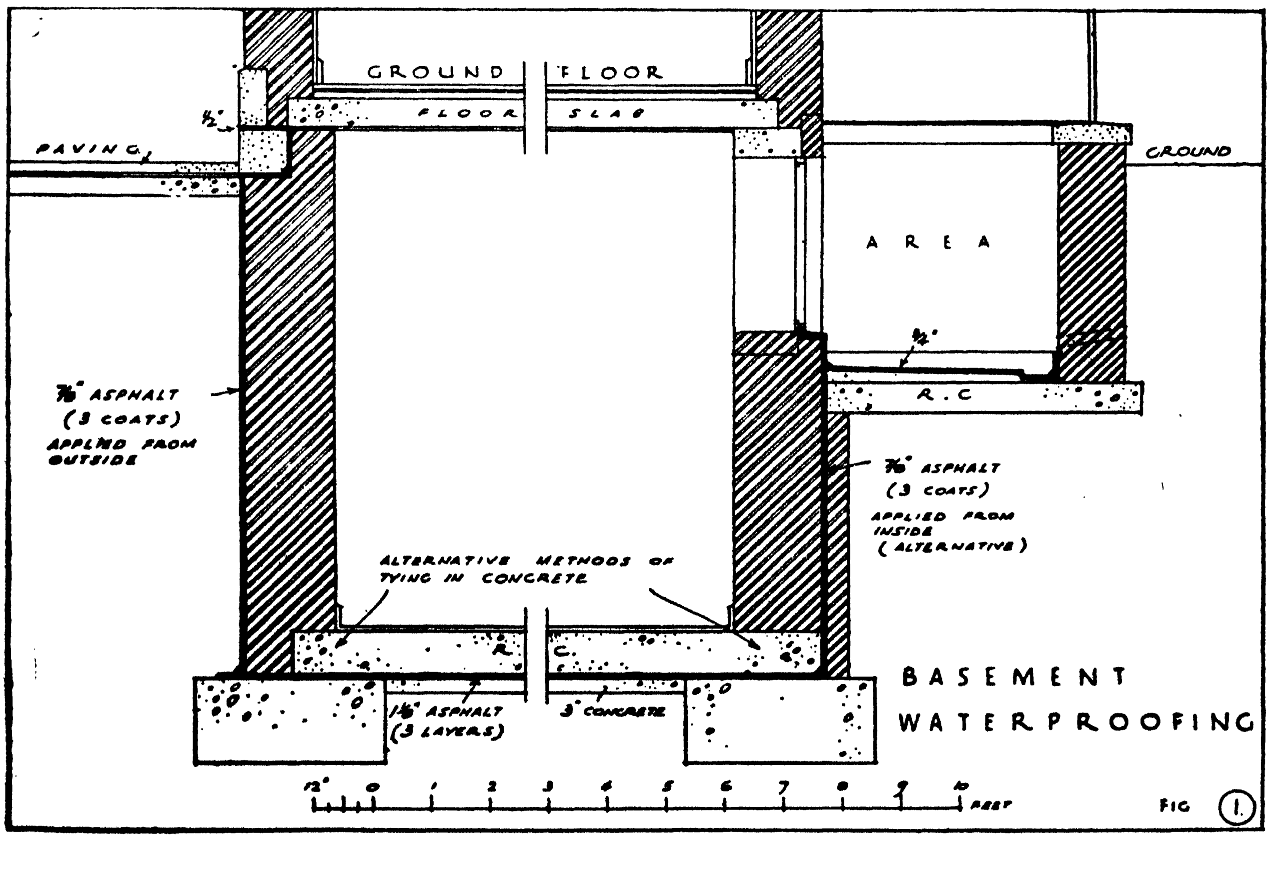


FIG 1.

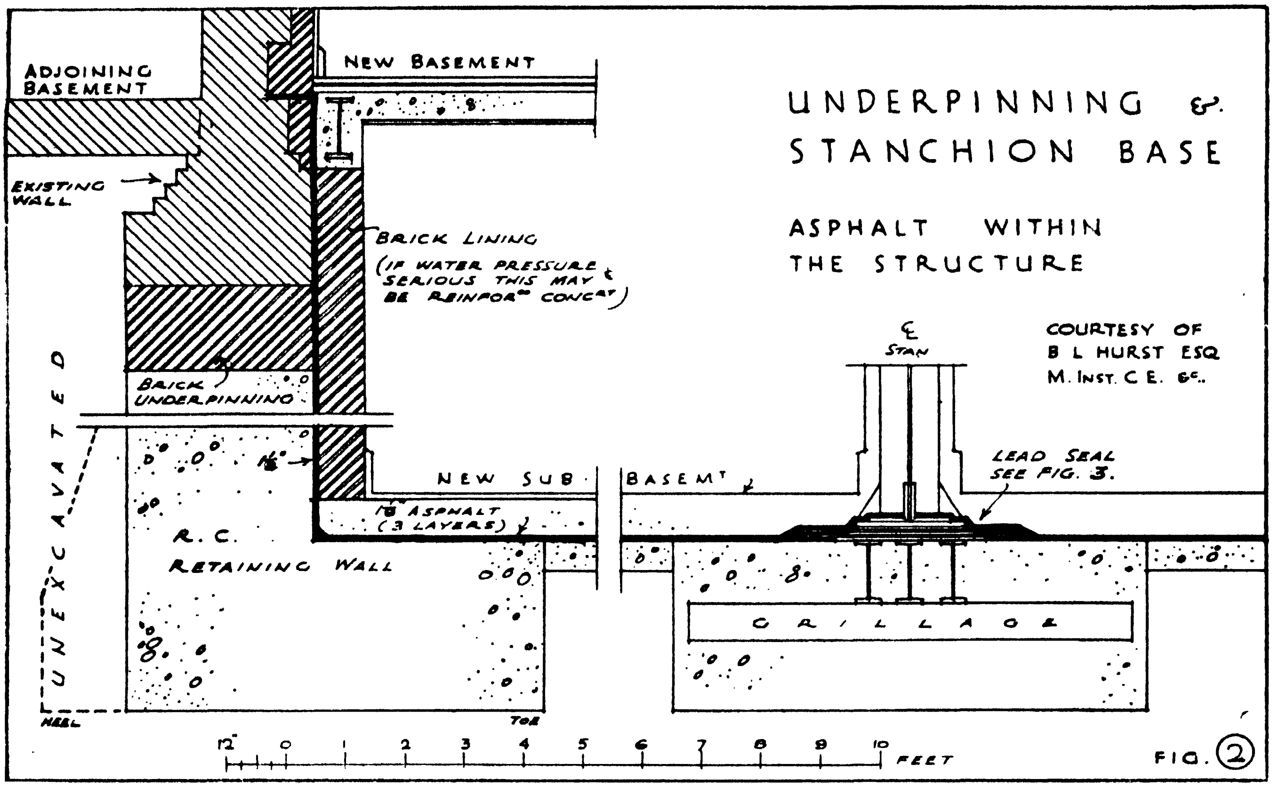

UNDERPINNING & STANCHION BASE
ASPHALT WITHIN THE STRUCTURE
COURTESY OF B L HURST ESQ M. INST. C E. &c.
ADJOINING BASEMENT
NEW BASEMENT
EXISTING WALL
BRICK LINING
(IF WATER PRESSURE SERIOUS THIS MAY BE REINFOR^D CONC^RT)
BRICK UNDERPINNING
UNEXCAVATED
R. C. RETAINING WALL
1/8" ASPHALT (3 LAYERS)
NEW SUB BASEM^T
STAN
LEAD SEAL SEE FIG. 3.
GRILLAGE
HEEL
TOE
12 0 1 2 3 4 5 6 7 8 9 10 FEET

FIG. 2

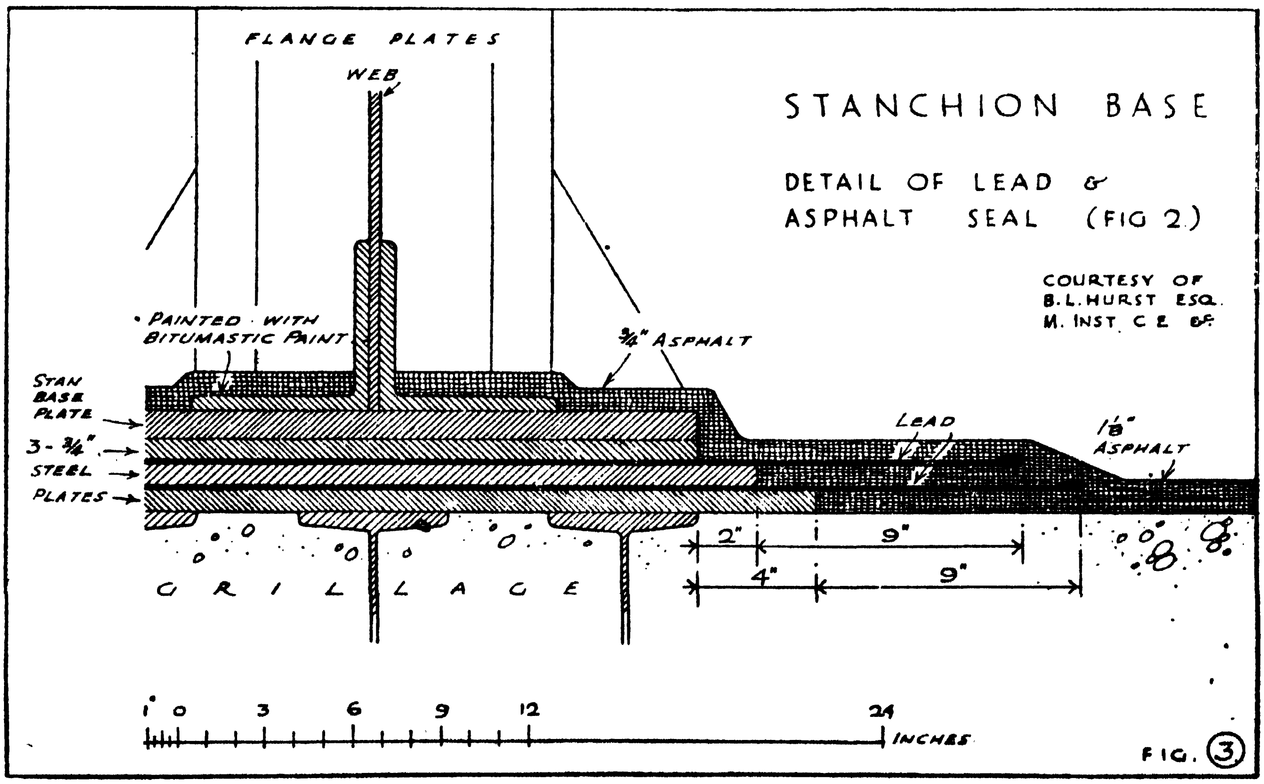

STANCHION BASE
DETAIL OF LEAD & ASPHALT SEAL (FIG 2)
COURTESY OF B.L.HURST ESQ. M. INST C E &c
FLANGE PLATES
WEB
PAINTED WITH BITUMASTIC PAINT
3/4" ASPHALT
STAN BASE PLATE
3 - 3/4" STEEL PLATES
LEAD
1/8" ASPHALT
2" 9"
4" 9"
GRILLAGE
1 0 3 6 9 12 24 INCHES

FIG. 3

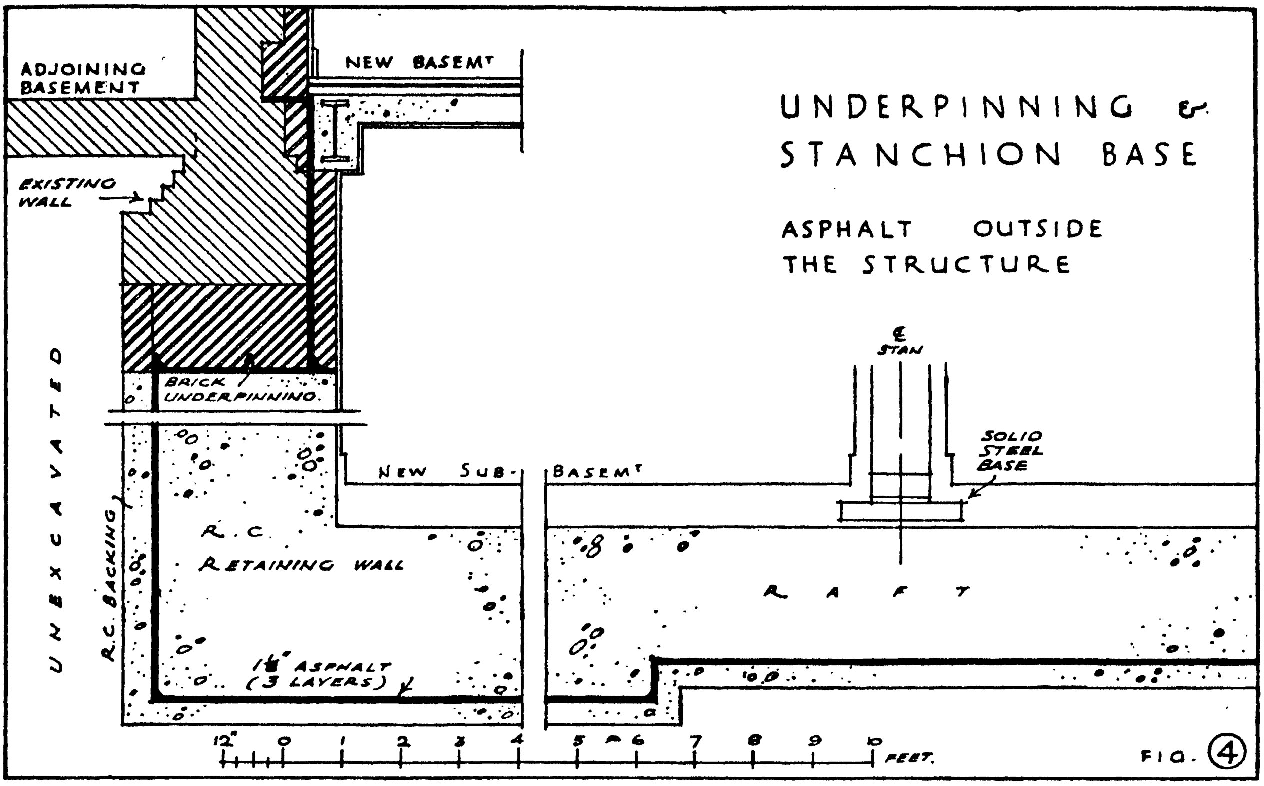


FIG. 4

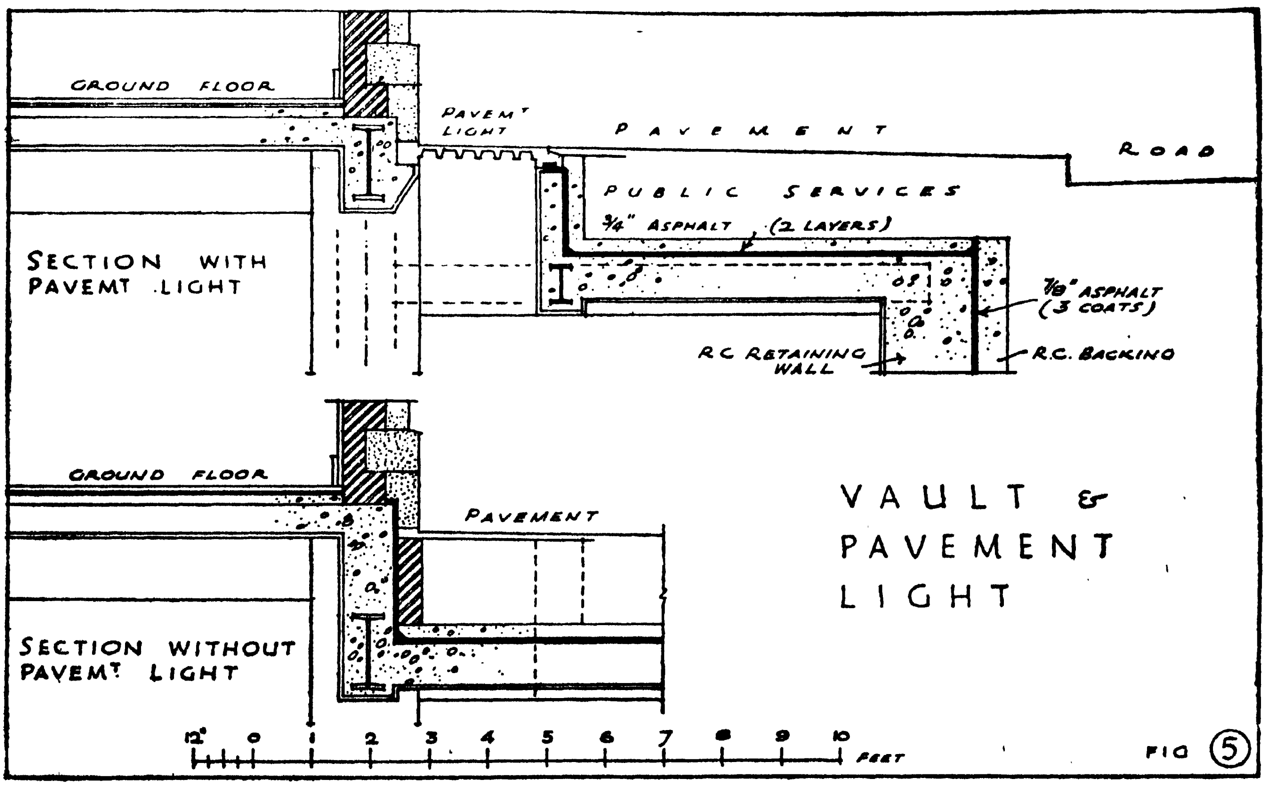
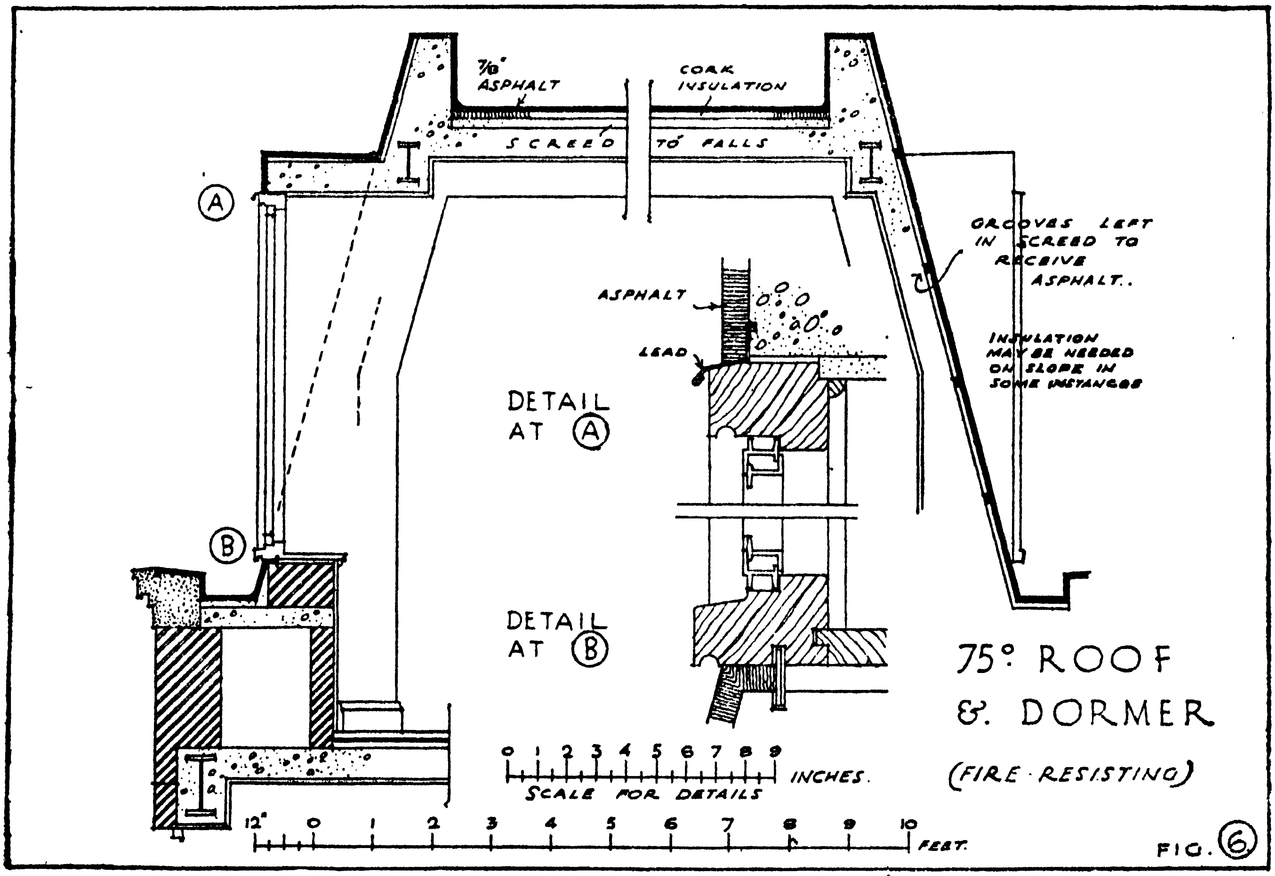
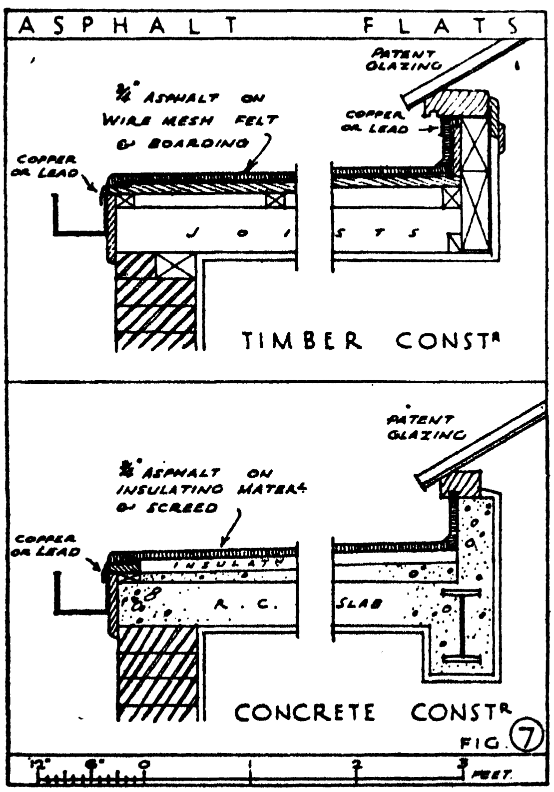
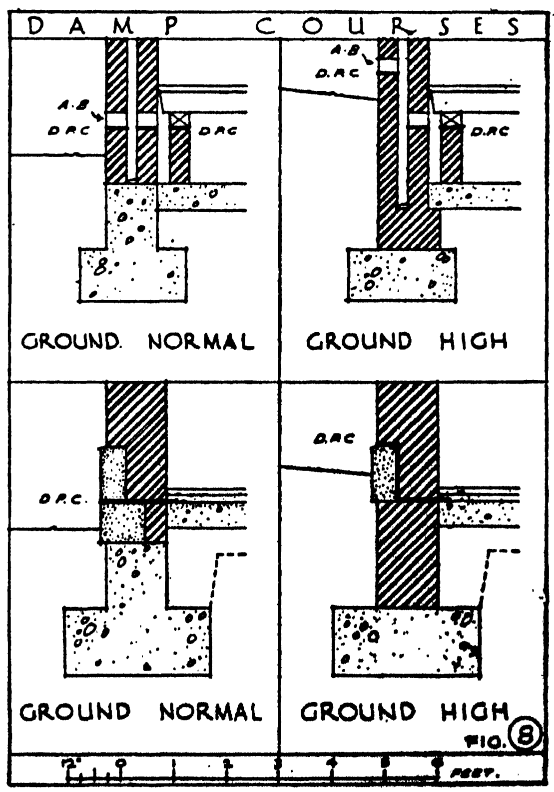


FIG 5

31576

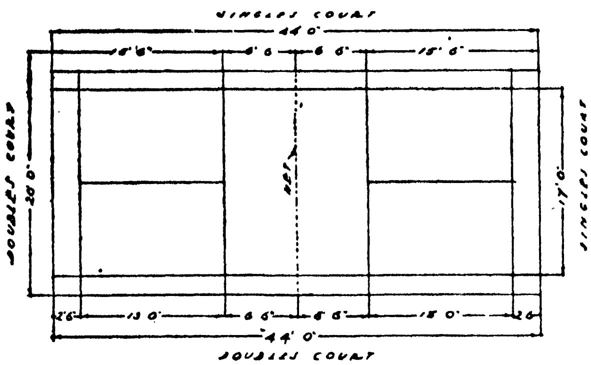

7/8" ASPHALT
CORK INSULATION
SCREED TO FALLS
A
GROOVES LEFT IN SCREED TO RECEIVE ASPHALT.
ASPHALT
LEAD
INSULATION MAY BE NEEDED ON SLOPE IN SOME INSTANCES
DETAIL AT A
B
DETAIL AT B
75° ROOF & DORMER
(FIRE-RESISTING)
0 1 2 3 4 5 6 7 8 9 INCHES.
SCALE FOR DETAILS
12" 0 1 2 3 4 5 6 7 8 9 10 FEET
FIG. 6


ASPHALT FLATS
PATENT GLAZING
3/4" ASPHALT ON WIRE MESH FELT & BOARDING
COPPER OR LEAD
JOISTS
TIMBER CONSTR
PATENT GLAZING
3/4" ASPHALT ON INSULATING MATER & SCREED
COPPER OR LEAD
INSULATN
R. C. SLAB
CONCRETE CONSTR
FIG. 7
12" 6" 0 1 2 3 FEET


DAMP COURSES
A.B. D.P.C
D.P.C
GROUND NORMAL
GROUND HIGH
D.P.C.
GROUND NORMAL
GROUND HIGH
FIG. 8
12" 0 1 2 3 4 5 6 FEET.

ATHLETIC MEMORANDA

BADMINTON COURT



BADMINTON COURT

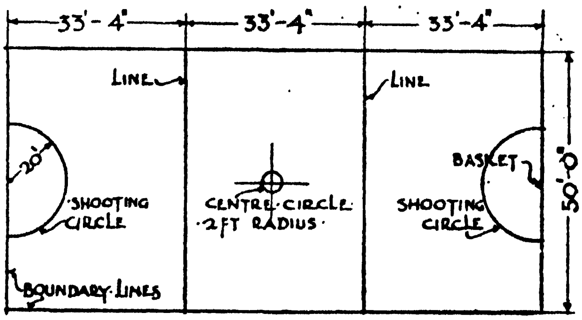
Doubles Court, 44′ × 20′

Singles Court, 44′ × 17′

Net posts 5′ 1″ in height are placed on the boundary lines where practicable, or outside these lines at a distance not exceeding 2′. Lines are $1\frac{1}{2}$″ wide in white or black.

A badminton court requires a minimum floor space of 54′ × 25′ clear of all obstructions.

BASKET BALL



·BASKET-BALL· COURT· FOR MATCHES·

The size of the court for inter-club and school matches must be 100′ by 50′, but the size may vary from 40′ by 60′ to 100′ by 150′. The court is divided into three equal areas by lines at right angles to the major axis. A circle 4′ in diameter is drawn at the intersection of the major and minor axes. The goals consist of wooden posts supporting baskets 18″ in diameter at a height of 10′ above the floor. This basket must be at the centre of the semicircle termed "shooting circle," which has a radius of 20′. The shaft supporting the basket may be hinged at the middle for convenience in storing, and the base, which is usually 3′ × 3′ in the form of a cross, is weighted for stability and made detachable.

A practice court may be about 70′ × 50′ and has a lane 6′ wide entering a circle of 6′ radius, both of which are forbidden ground for the opposing side.

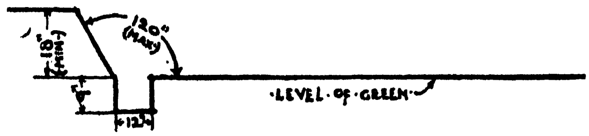
All lines are painted white or, if outside, set out with a tennis marker and are about 2″ wide.

BOXING

Under the Queensberry Rules, the size of the ring is 24′ square ; under National Sporting Club Rules the minimum is 14′ square, maximum 20 ′ square.

It is usual to raise the ring from 2′ to 3′ off the floor ; the surrounding ropes should be at least 3′ 6″ high. If seating is provided for spectators, the nearest seat should be at least 5′ from the edge of the ring.

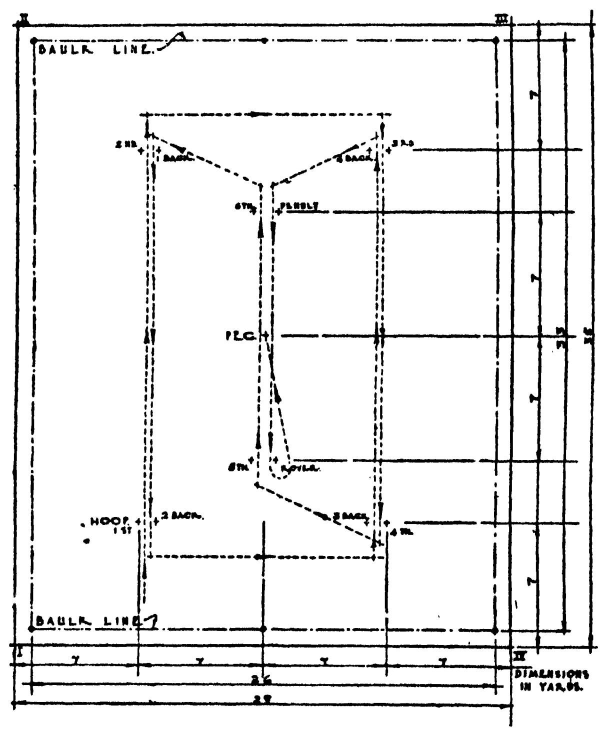
BOWLING GREEN



·PART· SECTION ·OF· BOWLING · GREEN·

The best shape for the green is square, so that the rinks may be laid out in either direction, the direction of the play being changed at intervals. The rinks should not be less than 19′ or more than 21′ in width. The green is 126′ square and should have a shallow ditch about 12″ wide and 9″ deep all round. It should also have, where possible. a bank all round of a height of 18″ from the level of the green, and inclined to the green at an angle not greater than 120°. (See sketch.)

CROQUET COURT

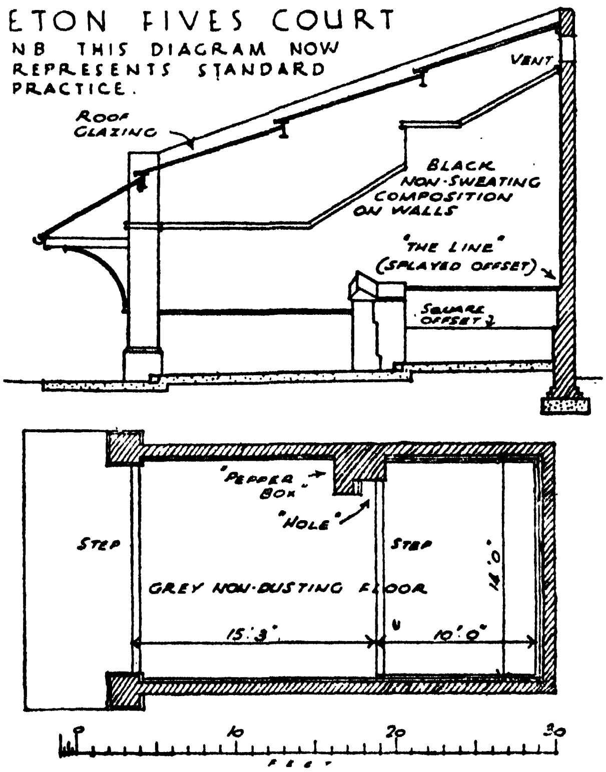


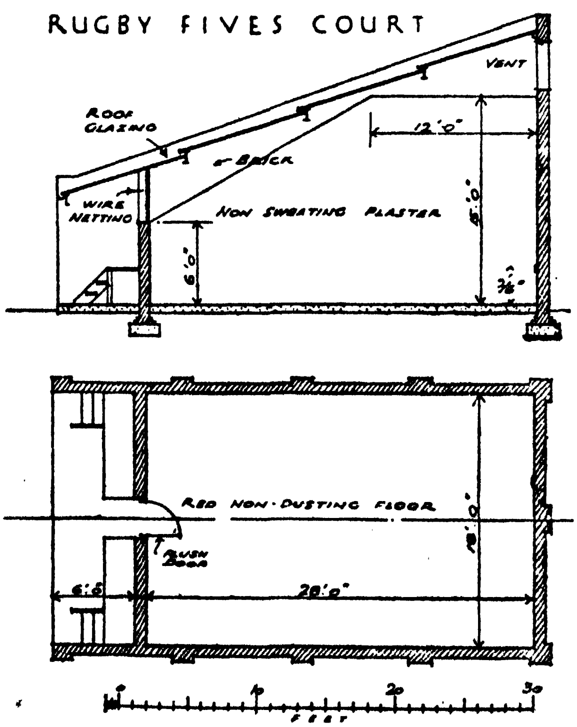
Standard Setting.

Only those portions indicated by a continuous line need be marked on the court. The order of making the points is indicated by the arrows.

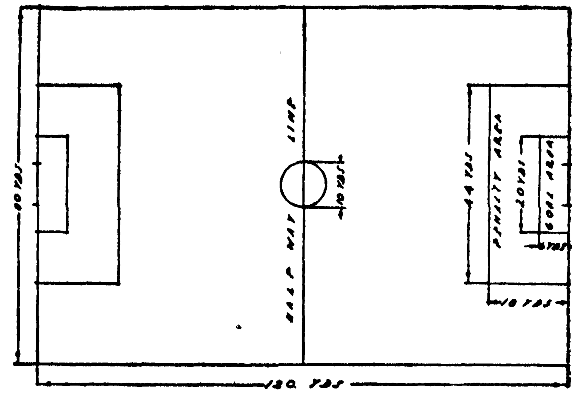
FIVES COURTS

	Length	Width
Eton Type	25′ 3″	14′ 0″
Rugby Type	28′ 0″	18′ 0″





FOOTBALL (ASSOCIATION)



ASSOCIATION FOOTBALL GROUND

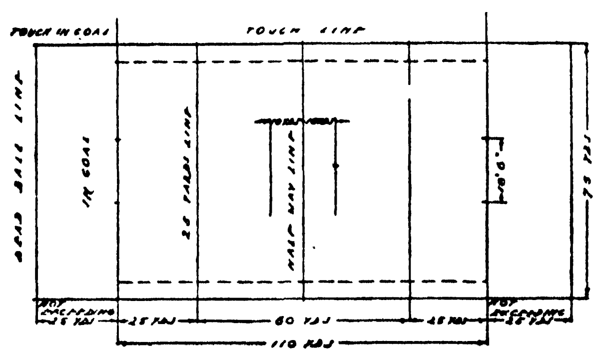
The following dimensions are taken from the Rules of the Football Association :—

General Play	Length	Width
Maximum	130 yds.	100 yds.
Minimum	100 yds.	50 yds.
Minimum for Schools	85 yds.	50 yds.
International Match Size :—		
Maximum	120 yds.	80 yds.
Minimum	110 yds.	70 yds.

Goal :—Width, 24′ ; Height, 8′.

Maximum width of goal posts and maximum depth of cross-bar shall be 5″.

FOOTBALL (RUGBY)



RUGBY FOOTBALL GROUND

	Length	Width
Minimum	110 yds.	75 yds.

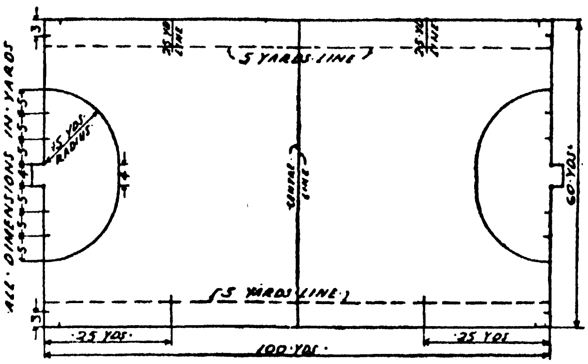
The dead ball line is at a distance not exceeding 25 yds. behind the goal line. Width of goal 18′ 6″ from inside to inside of goal posts.

10′ 0″ from ground to top edge of cross-bar.
Goal posts are 22′ high and 4″ × 3″.
Cross-bar 18′ 6″ long and 4″ × 2″.

GYMNASIA

The officially suggested minimum size for a school gymnasium is 70′ × 40′, and this may be taken as a generally applicable minimum size.

HOCKEY



Standard match size :—
Length 100 yds.
Width Not less than 55 yds. or more than 60 yds.

Other sizes

Women :—	Length	90 yds. to 100 yds.
	Width	55 yds. to 60 yds.
Schools :—	Length	85 yds. (minimum).
	Width	55 yds. (minimum).

Goal Posts.—These shall be 2″ wide and not more than 3″ deep and shall be 4 yds. apart with the cross bar 7′ from the ground (all inside measurements).

ICE HOCKEY

Playing Area :—Length, 180′, width 85′. The playing area is divided into three zones of equal length by transverse lines, as the rules differ in the three areas. The goals shall be formed by two vertical posts 4′ in height and 6′ apart, with their tops connected by a horizontal bar. The goals shall be placed at each end of the rink in the middle of the small side, the open part facing the centre and the goal line being parallel to the bottom line and placed at distances of 5′ (minimum) and 15′ (maximum) from the bottom line in proportion to the length of the rink.

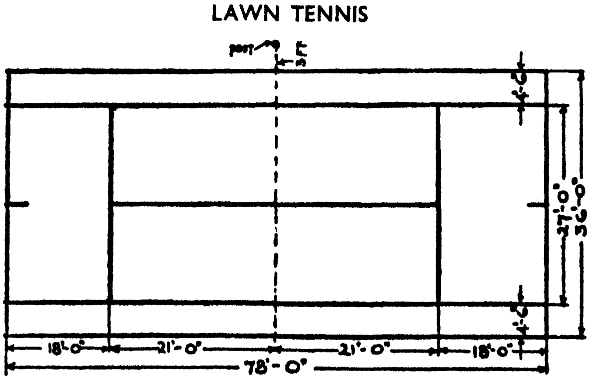
LACROSSE

Distance apart of goals :—

	Maximum	Minimum
Men	130 yds.	100 yds.
Women	110 yds.	90 yds.

Boundaries of the field of play have to be agreed upon by the captains before the commencement of the match.

LAWN TENNIS



·LAWN·TENNIS·COURT·

	Length	Width
Doubles Court	78′	36′
Singles Court	78′	27′
International Match Size of lawn : (minimum)	120′	60′

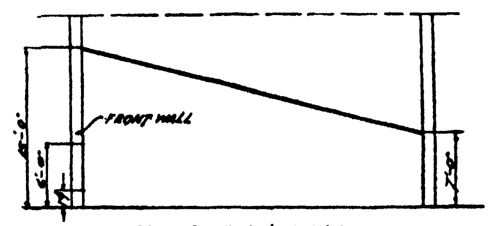
RACQUETS

The standard dimensions for a racquets court are as follows :—

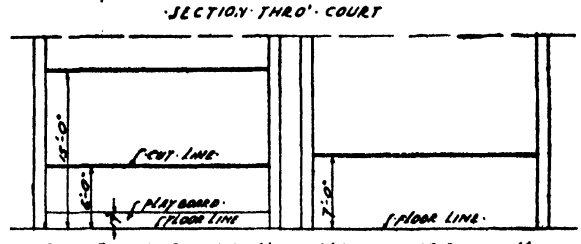
Length	60′
Breadth	30′
Height of front and side walls	28′
Height of back wall	12′ 6″
Distance of " short line " from front wall ...	46′
Height of " service line " on front wall ...	9′ 6″
Height of " board " from ground	2′ 3″
Service boxes from short line (inside measurement)	8′ 4″
Service boxes from side wall (inside measurement)	6′ 4″

The interior walls to the court must be coated with a black non-sweating material. The floor should be covered with black jointless or similar flooring. All play lines are painted cherry red, 2″ wide. The Board fixed at the bottom of the playwall is 6″ wide and 27″ from the floor to the top of the board. If top lit, approximately 55 per cent of the roof should be glazing. It requires approximately 5,000 watts to light a racquets court effectively.

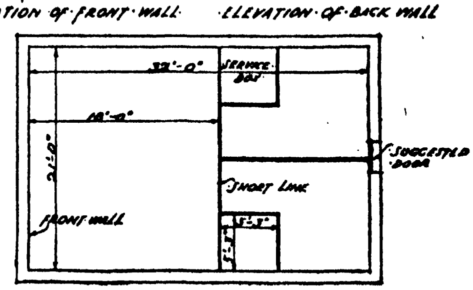
SQUASH RACKETS



·SECTION·THRO'·COURT



ELEVATION·OF·FRONT·WALL· ·ELEVATION·OF·BACK·WALL



PLAN OF·SQUASH·RACKETS·COURT

The standard dimensions of squash rackets courts are as shown on the sketches.

The floor is generally of maple in narrow widths, and provision should be made for expansion at the junction of the floor and walls. Skirtings, coves, or angle fillets must not be used on the playing surfaces. The floor should be resilient. Walls should be finished with " non-sweating " plaster. The portion of the wall under the playboard should be covered with sheet metal, or similar resonant material, to signify when the ball is out of play.

The doors must be flush and must not have any projecting ironmongery.

The balustrade to the gallery should be sufficiently rigid to withstand pressure by spectators, and the front of the gallery must be screened with netting.

If top lit, not less than 33 per cent of the roof should be glazed. Special care should be taken with the artificial lighting to obviate shadows, and the fittings should be so placed as not to interfere with the play. Six fittings are usually employed, the lamps being of 200 watts each.

Good ventilation is essential and may be obtained by natural means, but air inlets and extracts must not be fixed in any of the playing surfaces. Inlets may be fixed below the playboard of the front wall ; also at the back of the gallery. Extracts may be used in the roof or high up in the side walls.

The marking lines must not exceed 2″ in width and are coloured red.

SWIMMING BATHS

Dimensions.—The Amateur Swimming Association Championship Conditions require the following dimensions :

Length :

(1) Not less than 75′ for the 100 yd., 220 yd., and 500 yd. races.

(2) Not less than 165′ for the half-mile and mile races. The length is measured along the free water area, and is the distance between vertical ends of the bath.

Width :

The A.S.A. " Recommendations for Swimming Competitions " gives the following table showing the number of competitors starting in any heat, as determined by the width of the water space at each end free from steps or other projections from the sides of the baths :—

Width	No. of Starters
15 to 25′ ...	4
25 to 30′ ...	5
30 to 36′ ...	6
36 to 42′ ...	7
42 to 48′ ...	8

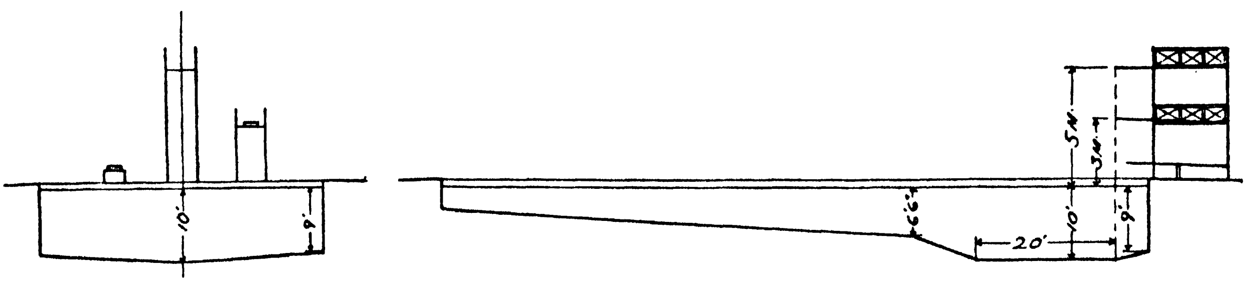
The type of pool having its deep area centrally placed, and two shallow ends has advantages for public open air baths which are apt to have a high proportion of tyros.

Depth :

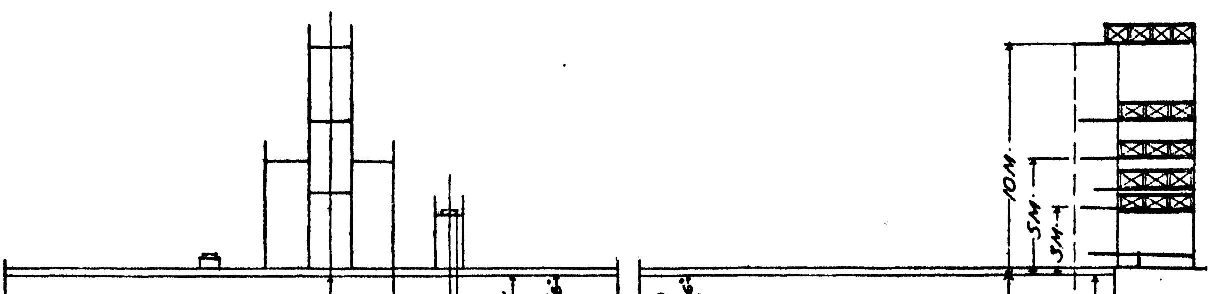
The A.S.A. Championship Conditions require that the course shall be at least 2′ 6″ deep.

Markings.—The various depths should be clearly indicated along the sides. In baths of the championship type, dark coloured lines about 6′ apart should be formed along the bottom of the bath for the guidance of swimmers. Markings may be formed in the surface material.

Gangways.—The gangways at the sides of the bath should not be less than 4′ 6″ wide, nor less than 6′ 0″ at the ends. All gangways should be laid to fall to a slope of about 1″ in 4′ in a direction away from the nosing of the bath. Any surface water draining from the gangways should discharge into a channel.



Sections of narrow bath with 5-metre diving board.



Sections of wide bath with 10-metre diving board.

Design of Deep Area.—(See Diagram.)—The greatest depth should be at a point immediately below the end of that running board which projects furthest over the water, and should be continued forward, as may be necessary, to suit the height and character of the various boards provided.
The rise from the deep area to the normal slope of the bottom should in all cases be at an angle of 20°. When possible, the point of change of slope between normal and steep should occur at a depth of 6′ 6″.
In baths about 40′ wide the deep area should extend right across the full width of the bath, with a slight rise towards the sides for drainage purposes. In wider baths the deep area should continue for a distance of at least 8′ on either side of the diving stage, the slope then continuing at 20° to 30° up to a minimum of 6′ 6″ at sides.

Standard International Heights of Diving Boards (as laid down by the International Amateur Swimming Federation) :

SPRING BOARDS	
Height of end above water	Depth of water
I metre	8′ 6″ (minimum)
3 metres . ..	10′ 0″ (8′ 6″ minimum)
FIRM BOARDS	
5 metres	10′ (9′ minimum)
10 metres	15′ (14′ minimum)

Generally, the height of a diving board above the surface of the water should never exceed twice the depth of the water, with a minimum depth of 8′ 6″ and a maximum of 15′. For sea water a slight reduction in the safe depths is possible.
A diving stage for the usual type of covered or open-air bath with a depth of water of 8′ 6″ to 10′ should include standard spring boards at heights of I metre and 3 metres, a firm running board at 5 metres and such intermediate boards as may be possible. Open-air baths with a depth of water of 14′ to 15′ should include the above equipment, and in addition a firm running board at 10 metres.
Ordinary running boards free from spring, or where only a slight spring is desired, should be of selected pitch pine of very straight grain, or some flexible hardwood well-seasoned and oiled with linseed oil. Standing boards and platforms should be of teak. Ladders should be of teak, or metal with teak treads.
The platforms of high diving stages may be in concrete brought to a smooth surface, or they may consist of timber or steel joists covered with teak planks. All boards should be covered with cocoanut matting. India rubber should never be used. Running boards and platforms should be covered throughout their entire length with strips about 20″ wide. The matting should not be wider than the board, otherwise the latter is continually wet and tends to warp ; but it should be turned down over the front end of the board and fixed beneath it, and should also be securely fixed at the back to prevent the possibility of its rucking up.

International Type Spring Boards

These are made of Oregon or Canadian pine, carefully selected for perfectly straight grain and freedom from knots and other defects which might cause the board to warp or crack. The 3-metre board is 16′ long and the I-metre board is 14′ long. Each is 20″ wide and 3″ thick from the back end to the front point of support, after which it tapers on the under side to a thickness of 1½″ at the diving end.
The boards are held down only at the back end, where they should be pivoted so as to recoil freely after the spring.

They merely rest on the front point of support, which consists of a length of steel barrel covered with a rubber sleeve, placed 8′ 7″ from the diving end for the 3-metre board and 8′ for the I-metre board, and arranged to be movable 2′ to 3′ backwards or forwards in order to secure the correct amount of spring and allow for variations of elasticity in the different boards.
The board is laid with a rise of 6″ from back to front, and a strong hardwood fillet should be bolted under the diving end to prevent warping.

Water Polo

Distance between goals : Maximum 30 yds. Minimum 19 yds. Width not more than 20 yds. Depth of water in any part must not be less than 3′.

Lighting

In covered baths the position of the artificial lighting must be carefully considered. The lights must not be placed where they may interfere with the free use of the diving stage either by baulking or dazzling the diver. Where flood lighting has been used, it has been found that it is often impossible to see the surface of the water when standing on the diving stage. This difficulty can be overcome by the provision of a top light in a suitable position.
In open air baths the position of the diving stage should be considered in reference to that of the sun, and where possible the stage placed so as to have the sun behind it.

Dressing Boxes.—These should not be less than 3′ 6″ square and should have removable draining boards. Dressing boxes are sometimes arranged so that the bather enters or leaves fully dressed at one side and in bathing costume at the other.
Showers and Lavatories.—At least one fresh water shower should be provided for every 40 bathers, one W.C. for each 40 women, and one W.C. and one urinal for each 60 men. Lavatory accommodation should adjoin, one basin being allowed for every 60 bathers.

Sunbathing Verges.—A verge for sunbathing in open-air baths is best made with pea shingle banked up to a gentle slope.

References

Handbook of The Amateur Swimming Association. "Modern Public Baths," by K. M. B. Cross. (1930. Simpkin Marshall Ltd. 2s. 6d.) The British Portland Cement Association Ltd., Handbook. "Open-air Swimming Baths."

BILLIARD ROOMS AND TABLES

The height of the room should be 12′ to 14′ and for a full size table the room should be a minimum of 24′ long and 18′ wide. Top lighting is best. Seats should be clear of playing space and raised where possible. The table should be erected with the door at the baulk end ; the spot end being nearest the window, so that a player playing from hand plays towards the light. The marking board should be at one side near the spot end, and the cue stand at the other. The space between two adjacent tables should never be less than 5′. A full size table is 12′ 9″ × 6′ 10½″ overall, and weighs (with the usual eight legs) 30 cwts.
A three-quarters size table is 10′ 9″ × 5′ 10½″ overall, and weighs (with the usual six legs) 20 cwts.
It is desirable to have rigid support under the legs of the table.

BOILER HOUSES

(See also " Fuels," p. 68.)

The essential requirements of Boiler Houses and Fuel Stores are :—

(1) Alternative means of escape must be provided. (Access to boiler houses should never be by ladder only.)
(2) Ample headroom and ventilation to provide air for the proper combustion of the fuel, and reasonably comfortable conditions for the stoker.
(3) Provision for removing the ash and clinker.
(4) Ample space for stoking and reasonable access to all parts for repairs and replacements.
(5) A continuous hard floor able to withstand hard knocks.
(6) Slip boards or other easy access to the fuel store for trimming purposes, with a hatch or opening for stoking purposes.
(7) Water supply for quenching ash or clinker.
(8) A drain or sump for emptying purposes to enable the system to be completely emptied.
(9) Where a sump is provided, it should have a pump of adequate capacity or a permanent connection to the nearest drain.
(10) Large installations should be provided with two or more boilers to provide a stand-by in case of failure, and also to enable the boilers to be operated economically by working them near their capacities according to climatic conditions.
(11) The boiler house floor level should be at least 1′ 6″ below the level of the lowest floor served to allow the return pipes to be connected to the boiler without rising.
(12) For small domestic premises having not more than 20,000 cu. ft. of space to be warmed, the boiler may be placed in the kitchen or other domestic office.
(13) In domestic work it is usually found more economical to instal two separate boilers, one for heating and the other for hot water supply, where more than 150 sq. ft. of radiation is required.

The following table of boiler house sizes may be followed for normal conditions, but for larger premises no table is possible :—

Cubic Contents to be heated up to :—	Heating Boiler only	Boiler Heating and H.W. Supply
20,000 cu. ft.	6′ 0″ × 5′ 6″	6′ 0″ × 8′ 0″
40,000 „	8′ 0″ × 6′ 6″	8′ 0″ × 8′ 6″
80,000 „	9′ 6″ × 7′ 0″	9′ 6″ × 9′ 6″
150,000 „	12′ 0″ × 8′ 0″	12′ 0″ × 11′ 0″
250,000 „	13′ 6″ × 10′ 0″	13′ 6″ × 13′ 6″

OIL FUEL

The use of oil fuel will not greatly affect the size of a boiler house as the space usually allotted to stoking, when solid fuel is used, will be required for the accommodation of pumps, fans or other gear forming the oil burning equipment. The main oil storage tank may be placed in any suitable position, preferably outside the boiler house, and may be of any shape convenient to the space into which it is to be fitted. If it is necessary to instal the tank in the boiler house, a wall or other enclosure must be built round to form a catch pit in case of leakage, and in most cases the Insurance Office concerned or the local authority will require the tank to be isolated completely from the boiler house.

In many cases the tanks are placed below ground, with a brick or concrete lining to the pit to facilitate renewals or repairs and resist corrosion. The tank is usually of mild steel (never galvanised), and may be cylindrical or rectangular. It should be fitted with a manhole and cover on the top and a small sump in the bottom to allow water or other impurities to be drained off, and with the usual filling, vent and gauge fittings.

The vent pipe should be at least as large in diameter as the filling pipe and the Insurance Company will probably require the vent terminal to be fitted with a double gauze cover. The vent pipe should be taken to a reasonable height above ground and the terminal should be kept away from windows.

SOLID FUEL

The average height to be reckoned for storage may be taken at 4′.

Description	Average weight in lb. per cu. ft. (broken up)	Space required per ton. cu. ft. (approx.)
Welsh Coal	58	40
Newcastle Coal ...	50	45
Scotch Coal	53	43
Anthracite Coal ...	55–60	40
Coke	28	80
Oil	56	40

COAL PLATES

Usually the diameter of coal plates allowed by local authorities in any public way must not exceed 14″.

BRICKWORK

STANDARD SIZES FOR BRICKS

The B.S.I., following the lead given by the R.I.B.A., recognizes two standard sizes for common building bricks, defined by B.S. 657 : 1941.

The depth of the brick is the only difference. In the greater part of the country this is 2⅝″, but in the type usual to the counties of Northumberland, Cumberland, Durham, Westmorland, Yorkshire and Lancashire it is customarily 2⅞″.

These recommendations are now generally adopted, but many special bricks are used for facings and before specifying the course heights and other dimensions the actual bricks should be measured. This is particularly necessary for large scale details, steel work, openings, etc.

BRICKWORK DATA

The standard thickness of brickwork for the purposes of measurement is 13½″ (1½ brick).

1 *rod of brickwork* =

- 272′ super—1½ brick thick.
- 306′ cube.
- 11⅓ yds. cube.
- 408′ super—1 brick thick.
- 4,310 (net quantity) stock bricks laid in mortar.
- 4,400 (gross quantity) ditto, allowing for waste.

1 rod of brickwork requires about 2 cu. yds. of mortar with ¼″ joints.

1 rod of brickwork requires about 3 cu. yds. of mortar with ⅜″ joints.

1 cu. ft. of brickwork requires 14 bricks net.

1 yd. super. requires 64 ordinary bricks—Flemish bond.

1 yd. super. requires 72 ordinary facing bricks English bond.

1 yd. super. requires 48 ordinary facing bricks—Stretcher bond.

1 cu. ft. of ordinary brickwork in lime mortar weighs 112 lb.

1 cu. ft. of ordinary brickwork in cement mortar weighs 121 lb.

1 cu. ft. of blue or glazed brickwork in cement mortar weighs 150 lb.

Brickwork laid dry requires 5,375 bricks to the rod in straight work and 4,900 in circular work such as cesspools and wells.

1,000 London stock bricks close stacked measure 50 cu. ft.

1,000 old London stock bricks cleaned and loosely stacked, 72 cu. ft.

WEIGHTS OF BRICKWORK

The following table gives the weights of Fletton brick walls in lime mortar. For Flettons in cement, multiply by 1·082. For Blue Staffordshire bricks in cement, multiply by 1·33. For cellular Flettons multiply by ·83.

Thickness of wall in in.	Weight in lb. per ft. run (height in ft.) 1	2	3	4	5	6	7	8	9	10
4½	42	84	126	168	210	252	294	336	378	420
9	84	168	252	336	420	540	588	672	756	840
13½	126	252	378	504	630	756	882	1008	1134	1260
18	168	336	504	672	840	1008	1176	1344	1512	1680
22½	210	420	672	840	1050	1260	1470	1680	1890	2100
27	252	504	756	1088	1260	1512	1764	2016	2268	2520

NOTES ON MORTARS

Sand for lime mortars should be substantially free from loam. Though hydraulic lime mortar has ample strength for normal building purposes, the maximum strength (as apart from the necessary strength) shows a very much lower factor of safety, and consequently any extraneous matter present in the sand, such as clay, will have a much greater percentage loss of strength in the mortar.

Sand and portland cement mortar should be substantially free from clayey inclusions, but since the strength of a cement mortar is much greater than that of the normal building brick, the decrease in strength due to the presence of clay, though appreciable, is much less as a percentage loss than where hydraulic lime is used.

Clay in a mortar has a definite retarding effect on the setting properties. Since in building with a hydraulic lime mortar it is often necessary to limit the height of building during any one day's operations because of its normal slowness of setting, to retard still further the setting of the mortar is inadvisable. Moreover, hydraulic lime mortar is sufficiently plastic in itself not to require the clay to lend " butteriness " to the mix. Similarly, the presence of clay in a P.C. mortar retards the setting, but with modern cements this perhaps is not a great disadvantage. On the other hand, cement and clean sand produce a " short " or " hungry " mortar and the presence of clay adds a butteriness which considerably assists in the spreading.

A good practical method for the mixing and use of gauged mortar is to prepare lime mortar in normal proportions of sand and lime, and—as each batch is taken from the heap for use—to mix in a measured proportion of one tenth (by bulk) of portland cement and use within half an hour.

Rules for mortar are given in the Model Byelaws issued from the Ministry of Health and it will be found that these are followed in local byelaws outside London. The byelaws of the L.C.C. differ in some respects.

EFFLORESCENCE

Apart from the introduction of salts in the actual bricks or in the sand used for mortar, salts causing efflorescence may be derived from the cementitious material. It is generally accepted that Portland cement, eminently hydraulic lime and moderately hydraulic lime contain salts in decreasing proportions, whilst white cement, aluminous cement and white lime are to all intents and purposes free from salts causing efflorescence.

A further matter of note in connection with efflorescence is that the salts generally appear on the most porous units of the wall. For example, if a soft brick is built in or pointed with a dense mortar it will often happen that salts derived from the mortar or pointing appear on the surface of the brick causing possible damage by subsequent surface disintegration. It is desirable to consider the bricks and use a less dense mortar, so that the greater amount of drying takes place from the mortar joints where, if any damage occurs, repointing of the work will be all that is necessary.

POROSITY OF BRICKS

The following points on porosity may be of interest :—

(1) Completely impervious bricks tend to give rise to much greater condensation than do porous bricks.

(2) Smooth and highly impervious bricks offer less key to the mortar, and capillary paths may be formed between the brick surfaces and the mortar joints.

(3) A porous brick has probably a higher thermal insulation value than an impervious brick.

(4) The aim for good brickwork should generally be relatively equal porosity for bricks and jointing material so that absorption properties do not tend to be concentrated either in bricks or jointing.

POINTING

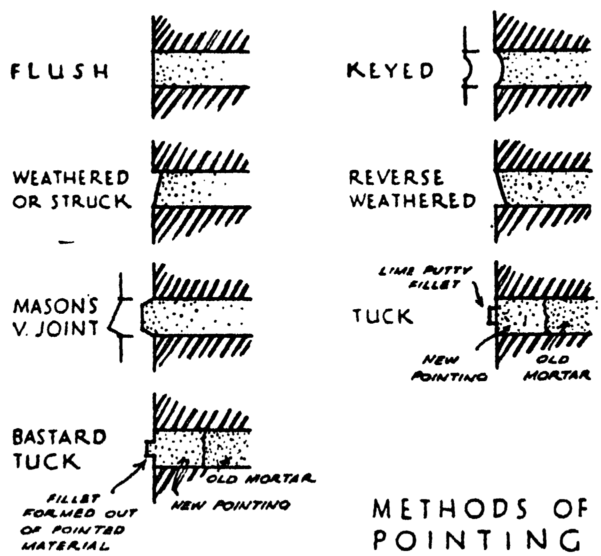
The repointing of old brickwork, particularly in the case of work in certain types of brick, is an operation requiring some care, and where the work is of any great importance the assistance of the Building Research Station should be obtained. Old brickwork is invariably built in a highly porous lime mortar which has always permitted the wall to dry out after each wetting, mainly through the joint. The usual custom is to repoint in a dense cement mortar, generally almost entirely impervious to moisture owing to the large proportion of cement used to give workability to the mix, and to the trowelling off given to produce a tidy joint. As a result, evaporation will normally be transferred to the face of the brick and will be somewhat slower, thus increasing the liability of frost damage. Apart from this, the salts which may be taken into solution by this water will be deposited on the face of the brick, and may cause disintegration by a process akin to exfoliation in stonework. Whilst these salts may derive from the existing brickwork, present-day knowledge of efflorescence suggests that they are more likely to derive in the main from the cement itself, Cases have been quoted of examples of early brickwork, which has weathered satisfactorily for long periods, breaking up soon after repointing with dense cement. Such pointings also tend to crack into short lengths by the actual contraction of the cement on setting, and so fall out unless the joint has been very deeply raked. Even when this is done, the formation of a thin layer of crystals between the new pointing and the old mortar—due to the drying out of water containing salts in solution—is sufficient to dislodge the pointing, and may even cause spalling of the edges of the bricks.

It is suggested that where cement is used, mixes of not more than, say, six to one should be specified. Such a mix will be almost impossibly "short" to work, but this can be overcome by the addition of sufficient lime to provide the butteriness or workability required for this operation. This may be grey or white lime in the hydrated form. In order to prevent the formation of a fatty impervious skin it is recommended that, after work is done and before the mortar has set, the surface be brushed over with a fairly stiff hand brush.

In order to reduce the amount of soluble salts added to the wall during repointing, white cement may be used in lieu of common Portland. Very little material is needed, so that the extra expense is not great. Alternatively, certain of the greystone limes may be used ; but unless these can be obtained ready hydrated, there may be some risk that they will be improperly slaked, as few workmen are likely to be experienced in their use. It should be noted that such limes are slower setting than modern Portland cement and are liable, unless care is taken, to dry out before setting can take place.

In all cases the joints should be very thoroughly raked, and the wall kept well wetted both before and during pointing. Work should not be done in hot dry weather, as it is then impossible to prevent too rapid drying.

The following diagram illustrates the various methods of pointing :—



METHODS OF POINTING

References

"The Mechanical Properties of Bricks and Brickwork Masonry." Building Research Station, Special Report No. 22. H.M.S.O. 1s. 3d.

P.W.B.S., No. 18 "The Architectural Use of Building Materials." H.M.S.O., 1946. 2s. 6d.

See also under "Brickwork" in Bibliography, p. 161, and under "Lime" on p. 110.

BRIDGES

BRIDGES OVER ROADS

These are subject to the provisions of the Railway Clauses Consolidation Act, 1845, if they carry a railway over a road or a road over a railway.

BRIDGES OVER STREETS

Section 27 of the Public Health Act, 1925, in most provincial areas prohibits, except by licence of, and subject to conditions laid down by, the local authority the erection of bridges or other similar structures over any streets. Certain conditions as to the terms of such licences are set out in the Act, which also provide for an appeal to Quarter Sessions. There is a parallel provision, but without any provision for appeal, in the London Building Acts Amendment Act, 1939.

BRIDGES UNDER THE CONTROL OF THE LONDON COUNTY COUNCIL

Byelaws made in respect of these bridges limiting weight of vehicles, etc., are given in the "Byelaws and Statutory Regulations," No. 2,865, Price 7s. 6d., from P. S. King and Staples, Ltd., 14, Great Smith Street, London, S.W.

BRITISH STANDARD SPECIFICATIONS

See pages 169 to 176 for classified list of British Standards applicable to building work.

CARPENTER AND JOINER

MARKET FORMS OF TIMBER

The following is a list of the principal forms into which soft woods are converted for the market :—

A *cord* is a measure of volume of wood varying in different districts and generally applied only to waste branches (lop and top) for firewood. Roughly the pile may be 14′ × 3′ × 3′, or 8′ × 4′ × 4′, and is about 126 to 130 cu. ft. ; the more generally accepted figure being 128 cu. ft. A *log* or *stick* is the trunk of the tree after it has been felled, with the branches lopped off.

A *balk* is a log roughly squared into shape.

Balk timber or *square timber* consists of the trunk hewn square, generally with the axe, but sometimes with the saw.

A *plank* is a squared piece of timber generally sawn from the balk, and usually 11″ wide, and from 2″ to 6″ in thickness.

Scantling is a general term applied to the various sizes of sawn timber.

A *deal* resembles a plank, but is from 7″ to 11″ wide (chiefly 9″), and not exceeding 4″ in thickness.

Whole deals are 2″ or more in thickness.

Cut deals are less than 2″ thick.

A *batten* is similar to a deal, but less than 7″ in width, and generally 1½″ and 2″ thick.

A *quartering* is squared timber varying in size from 3″ × 3″ to 4½″ × 4″.

A *St. Petersburg Standard* is 165 cu. ft. = 60 deals 12′ × 11″ × 3″. A *London Standard* is 270 cu. ft. = 120 deals 12′ × 9″ × 3″.

Deals, battens and quarterings for joists, rafters, plates, etc., are sold at per standard of 165 cu. ft., and in smaller quantities at per cu. ft.

Floor, slate and tile battens and strips are sold at per 100′ run.

Lathing :—1″ × ¼″, 3/16″. Sold at per bundle.

Feather edge boards :—¾″ × ¼″ × 7″, 6″, 4½″, 4″. Sold at per square.

Joiners' stuff, floorings, matchings, sold at per standard of 165 cu. ft., and in smaller quantities at per 100-ft. run ; floorings and matchings at per square.

British Columbian or Oregon Pine is produced in the usual

" Deal " scantlings, and also in random widths of various thicknesses such as :—

6", 5", 4", 3", 2", and from 5", to 24" wide.

It is usually listed 6" to 16", 10" to 18", 12" to 20", etc.

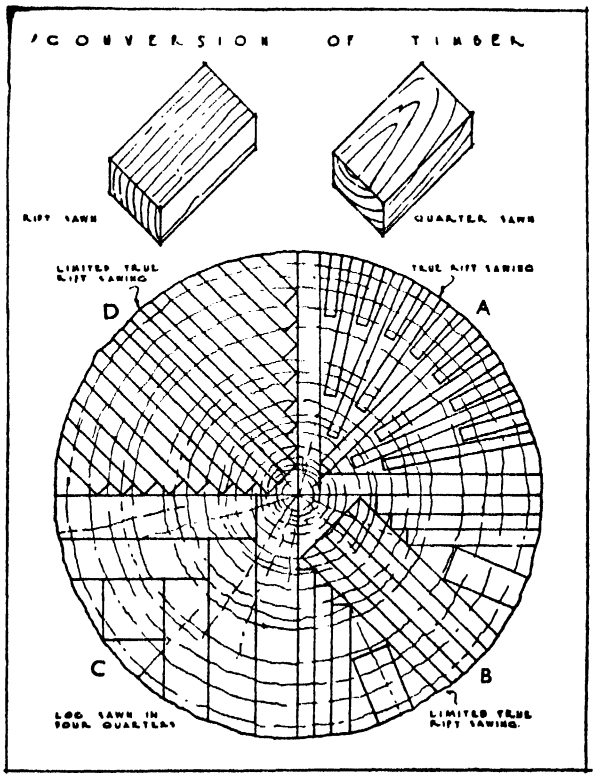
CONVERSION OF TIMBER

The diagram below will serve to explain the meaning of the terms " Rift Sawn " and " Quarter Sawn."

A is theoretically true rift sawing, being at right angles to the growth rings, but is wasteful and not usually done.
B is wasteful and not often done.
C is usual for joinery such as quartered oak.
D is usual to obtain the best figure in oak.
D and C are the most usual methods.

Rift sawing is essential for soft woods in wood block flooring and for good quality strip flooring.

When rift sawn is specified, not less than 90 per cent of the material should be rift sawn. Timber specified simply as " rift sawn " is not usually supplied more than about 90 per cent true rift sawn, and if a greater percentage is required the percentage should be specified.



SIZES OF FLOOR JOISTS FOR DOMESTIC BUILDINGS

A general rule for Domestic Floor joists of 2" width is :— Depth in inches equals

$$\frac{\text{span (in feet)}}{2} + 2''$$

Minimum sizes for joists for various spans have been occasionally specified in local byelaws in the past, but have never been included in the model byelaws issued by the Ministry of Health. Such byelaws, outside London, will not often be found still to exist. The L.C.C., however, whose byelaws do not follow the model byelaws, have a special series with respect to timber sizes.

Appendix E of *Ministry of Health Housing Manual*, 1944, gives tables of sizes : span : spacing considerably below those previously general, of which the following may serve as an example :—(All European softwood).

Scantling	Floor Joist Span	Ceiling Joist Span	Rafters (measured along slope)
in.	ft. in.	ft. in.	ft. in.
2 × 3	3 6	6 0	6 6
2 × 4	6 0	8 1	8 6
2 × 5	8 4		
		Purlins (6′ 0″ apart)	(7′ 0″ apart)
		span	span
2 × 6	10 2	6 2	5 9
2 × 7	12 0	7 3	6 8
2 × 8	13 10	8 2	7 6
2 × 9	15 7	9 2	8 4

STRUTTING

Floor joists with a span exceeding 8′ require strutting. Herringbone or solid strutting should be spaced at 6′ to 8′ centres. Herringbone strutting is usually 1½" × 1½". Solid strutting is usually 1½" thick and ½" less in depth than the joists and kept flush with the tops.

WALL PLATES

These are 4" × 3" where necessary to line up with brick joints ; otherwise they may be 4" × 2". Where the joists are built into the wall a 2" × ¼" tarred and sanded steel bearing plate is preferable to a wooden plate.

Sometimes, at intermediate floor levels, wall plates are omitted and the wooden joists built into the wall with their ends creosoted.

TIMBER PARTITIONS

These should rest upon double joists wherever practicable, but should they occur parallel to and between joists, bearers should be provided. The double joists should be blocked out to a distance of not less than 1" apart, to avoid breaking the key of the plaster. Partitions at right angles to the joists should rest on a sole piece.

WORKING STRESSES FOR TIMBER

See B.S. 940, Part I : 1944, Part II : 1942. " Grading Rules for Stress-graded timber and structural timber."

See also Appendix E to the Ministry of Health Housing Manual : " The Scientific Use of Timber." This gives working stresses for various available timbers and recommended sizes for joists and rafters.

TIMBER ROOFS
SIZES OF SCANTLINGS
COUPLE CLOSE ROOFS

Rise—½-span. Covering—Slates on boarding

Span of Roof ft.		Rafters in.		Ridgeboard in.		Ceiling joists in.
8	......	3 × 2	......	7 × 1½	......	4 × 2
10	......	4 × 2	......	7 × 1½	......	5 × 2
12	......	4 × 2	......	7 × 1½	......	6 × 2
14	......	5 × 2	......	7 × 1½	......	7 × 2
16	......	5 × 2	......	8 × 1½	......	8 × 2
18	......	6 × 2	......	8 × 1½	......	9 × 2

Note.—If the ceiling joists are supported at centre, the depths of same may be reduced to one-half those given.

COLLAR BEAM ROOFS

Pitch up to 30°. If pitch 45° add 1" to depth of rafters. Collars, ⅓ the rise up. If ½ the rise up, add ¼" to the breadth and depth of rafters, and 1" to depth of collars.

Span ft.	Rafters: No. ceiling in.	Rafters: Ceiled to collars in.	Collars: No. ceiling in.	Collars: Ceiled to collars
8	... 3 × 2	... 4 × 2	... 2 × 2	Width 2", depth ½", plus ⅛" for every ft. of clear length of underside of collar
10	... 4 × 2	... 4 × 2	... 3 × 2	
12	... 5 × 2	... 5 × 2	... 3 × 2	
14	... 5 × 2	... 6 × 2	... 3 × 2	
16	... 6 × 2	... 6 × 2	... 4 × 2	
18	... 6 × 2	... 7 × 2	... 4 × 2	

KINGPOST AND QUEENPOST TRUSSES

For trusses, 10' centre to centre, constructed of best quality material and workmanship.
Pitch, up to 30°.

Span Ft.	Tie Beams in.	Principal Rafters in.	Kingpost Shaft in.	Struts in.	Queen post Shaft in.	Straining Beams in.	Purlins in.	Common Rafters in.
20·0	4 × 7	4 × 4	4 × 3	4 × 3	...	...	5 × 7	2 × 3
22·0	4 × 8	4 × 4½	4 × 3	4 × 3	...	...	5 × 8	2 × 3½
24·0	4 × 8	4 × 5	4 × 3	4 × 3	...	...	5 × 8	2 × 4
26·0	4 × 9	4 × 6	4 × 3½	4 × 3½	...	...	5 × 8	2 × 4
28·0	4½ × 9	4½ × 6	4½ × 3	4 × 3½	...	...	5 × 9	2 × 4½
30·0	5 × 9	5 × 6	5 × 3	5 × 4	...	...	5 × 9	2 × 4½
32·0	4½ × 8	4½ × 6	...	4½ × 3	4½ × 3	4½ × 7	5 × 8	2 × 3
34·0	5 × 8	5 × 6	...	5 × 3	5 × 3	5 × 7	5 × 8	2 × 3½
36·0	5 × 8	5 × 6	...	5 × 3	5 × 3	5 × 8	5 × 8	2 × 4
38·0	5 × 8½	5 × 6	...	5 × 3	5 × 3	5 × 8	5 × 8	2 × 4
40·0	5 × 9	5 × 6½	...	5 × 3	5 × 3½	5 × 9	5 × 9	2 × 4½
42·0	5½ × 9	5½ × 6	...	5½ × 3	5½ × 3½	5½ × 9½	5 × 9	2 × 4½
44·0	5½ × 10	5½ × 7	...	5½ × 3½	5½ × 3½	5 × 10	5 × 9	2 × 5
46·0	5½ × 10	5½ × 7	...	5½ × 3½	5½ × 4	5½ × 10	5 × 9	2 × 5

If pitch is 45°, add 1" to depths of struts, purlins and common rafters, and ½" to depths of principal rafters, as given in above table.

MANSARD TRUSSES

Trusses 10' apart

Span in ft.	Tie Beams	Principal Rafters	Queenpost Shaft	Curbs
22·0	11 × 5	6 × 5	6 × 5	6 × 4
26·0	11 × 6	7 × 6	7 × 6	6 × 4
30·0	12 × 7	8 × 7	8 × 5	6 × 4

The dimensions for the upper parts of Mansard trusses may be taken from the table of Kingpost trusses.

SAFE LOADS ON RECTANGULAR BEAMS

(Northern Pine or Baltic Fir.)
for each 1" of width ; load distributed uniformly.
Safe stress, 1,000 lb. per square inch.
Deflection not exceeding 1/360 span.
Loads above zigzag line are calculated on shear stress.

Span in Feet	3	4	5	6	7	8	9	10	11	12	14	16
	Depth in inches and Safe Load in Pounds											
4	250	444	555	667	778	889	1000	1110	1222	1333	1556	1778
5	160	355	555	667	778	889	1000	1110	1222	1333	1556	1778
6	110	263	462	667	778	889	1000	1110	1222	1333	1556	1778
7	—	193	377	571	778	889	1000	1110	1222	1333	1556	1778
8	—	150	290	500	681	889	1000	1110	1222	1333	1556	1788
9	—	—	228	395	605	790	1000	1110	1222	1333	1556	1778
10	—	—	185	320	508	711	900	1110	1222	1333	1556	1778
11	—	—	—	265	420	628	818	1010	1222	1333	1556	1778
12	—	—	—	222	352	527	750	926	1120	1333	1556	1778
13	—	—	—	—	300	449	639	855	1034	1231	1556	1778
14	—	—	—	—	260	388	550	757	960	1143	1556	1778
15	—	—	—	—	—	337	480	659	876	1067	1452	1778
16	—	—	—	—	—	296	422	578	770	1000	1361	1778
17	—	—	—	—	—	—	373	512	682	886	1281	1674
18	—	—	—	—	—	—	333	457	609	790	1210	1581
19	—	—	—	—	—	—	—	410	546	710	1126	1498
20	—	—	—	—	—	—	—	370	492	641	1016	1423
21	—	—	—	—	—	—	—	—	447	581	922	1355
22	—	—	—	—	—	—	—	—	407	529	841	1254
23	—	—	—	—	—	—	—	—	—	484	770	1147
24	—	—	—	—	—	—	—	—	—	445	706	1053

Example.—Find the safe uniformly distributed load that can be applied to a beam 10" deep × 6" wide, spanning 12'.
From the table the safe load for a width of 1" is 926 lb. Hence the safe distributed load is 926 × 6 = 5556 lb. = 49·6 cwt.

BEAMS—TIMBER.

The strength of simple rectangular timber beams may be estimated by the following formulae :—

Where W = the safe load in cwts.:
k = constant (see below).
b = breadth of beam in inches.
d = depth of beam in inches.
L = span of beam in feet.
f = factor of safety.

(a) For a central load on a simple beam ... $W = \frac{kbd^2}{fL}$

(b) For an uniformly distributed load, on a simple beam ... ... $W = \frac{2kbd^2}{fL}$

(c) For a cantilever with a load on its unsupported end ... ... $W = \frac{kbd^2}{4fL}$

(d) For a cantilever with an uniformly distributed load ... ... $W = \frac{kbd^2}{2fL}$

VALUES OF K.

English Ash	6·0
Beech	4·5
English Elm	3·0
Fir, White Spruce	3·0
English Oak	4·5
American White Oak	2·0
Baltic Oak	3·0
Pine, Northern Dantzig and Memel ...	3·0
Pine, Northern Riga...	3·0
Pitch Pine	4·0
Teak	6·0
Oregon	2·5

For timbers in permanent work a factor of safety of 6 to 8 is usual.

STRUTS AND POSTS.

The following table gives the safe stress in cwts. per square inch on struts of fir axially loaded, for the various ratios of length L, in inches to the least dimension, D, in inches. The table is based on a factor of safety of about five. Should a higher safety factor be required, the stresses must be correspondingly reduced.
For eccentric loading, such as loads applied from one side only, or at right angles (corner post), special calculations are necessary.
For oak multiply loads given by 1-1/3rd.

L/D	cwts.	L/D	cwts.
11	6½	21	3⅜
12	6¼	22	3¼
13	5¾	23	3
14	5⅜	24	2¾
15	5	25	2⅝
16	4¾	26	2¼
17	4⅜	27	2
18	4	28	1¾
19	3¾	29	1⅝
20	3⅝	30	1½

References :

Forest Products Research publications. Timber Development Association publications (listed on pp. 162 and 168). P.W.B.S. No. 15 " Floors, Walls and Roofs." H.M.S.O., 1944. 9d.
Ministry of Health " Housing Manual."

See also : Headings FLOORS and FLOORING, TIMBER and TIMBER PRESERVATION, PLYWOOD.

CARPETS

English weaves of carpet have rather confusing technical names. They have various restrictions as to designs and sizes, and not all are available for specialist orders, being normally made in bulk for retail distribution.
Seamless carpets are usually quoted per sq. yd., and seamed piece goods per lineal yd. by the selected width.
Broadly, the more general weaves are :—

Wilton and Saxony Piles

The weaving principle of these is the same, distinction being in the pile yarn. Wilton is worsted and Saxony is woollen yarn.
They are made both plain and patterned : the latter usually confined to five colours maximum.
The most usual and economical width is 27″, known as threequarter wide.
Other standard widths are multiples of 9″ (quarter of a yd.) ; namely, 2/4 (18″), 5/8 (22½″), 4/4, 5/4, 6/4, 7/4 and 8/4.
Prices are generally quoted for full pieces 40/50 yds. long. Price in October, 1946, 27″ wide from 17s. 6d. to 35s. 0d. per yd.
Seamless Wilton carpets are bulk made by certain manufacturers for retail distribution, in rectangular sizes, ranging from rugs up to carpets 12′ wide and of proportionate lengths.

Hair Carpet and Brussels

Brussels carpets may be described as " Looped pile Wilton " and the same facilities apply.
Hair Carpet.—This is a cheaper Brussels weave. The same facilities apply as for Wilton carpets in plain colours, but it is not usually made wider than 4/4 (36″).
The price in October, 1946, for Hair Pile 27″ wide was 16s. 8d. per yd.

Axminster

This term is given to several different weaves :—

Handtufted (Real) Axminster

This is entirely hand-woven, permitting unrestricted freedom in design and colour. The seamless sizes extend to 40′ wide by any length, and to any shape. Qualities range from those having about 12 knots per sq. in. to 100 knots.

Chenille Axminster

This is a machine-woven seamless carpet in sizes up to about 30′ wide by any length, in both plain colours and designs. This weave has technically almost the same freedom in design as Handtufted carpets, subject to considerable differences in prices ruling for plain or patterned.

Spool Axminster

This weave is usually confined to cheaper qualities, and made in bulk, both plain and design.
Standard widths, as with Wilton, are 3/4 (27″), 2/4, 5/8 (22½″) and 4/4.
Some Stock facilities are available.
Seamless carpets are made by certain manufacturers for Store distribution.

Gripper Axminster

This comparatively new weave may be classed with Spool Axminster, and is mostly used for the cheaper seamless carpets of normal sizes.
The price of Axminster Carpet, 27″ wide in October, 1946, was 20s. 0d. to 30s. 0d. per yd.

CARS

(See " Garages.")

CELLARS AND VAULTS UNDER PAVEMENTS

L.C.C. Byelaws, January, 1938. Byelaw 139.
Every arch or other construction under any passage leading to premises in other occupation shall be formed of brick or stone or other incombustible materials not less than 5″ thick, and shall be of adequate stability to the satisfaction of the District Surveyor to support such a load as may be likely to be imposed on it.
Every arch or other construction under any public way or intended public way (other than a passage leading to premises in other occupation) shall be constructed as above, provided, however, that these requirements shall not prohibit the formation of pavement lights in any such construction.
Section 26 of the Public Health Act, 1875, requires consent of the local authority (outside the London area) to the making of any vault, etc., under the carriage way of any street. This does not apply to vaults, etc., under pavements. But Section 35 of the Public Health Acts, Amendment Act, 1890, requires the owner of such a vault, etc., to keep it in repair. There are similar provisions in the London statutes, going rather farther, e.g., 53, 101, 102 of the Metropolis Management Act, 1855.

CENTRAL HEATING

(See also " Fuels " and " Boiler Houses.")

Post-War Building Studies, No. 19, " Heating and Ventilation of Dwellings "—H.M.S.O., 1945, 2s. 6d. net—contains a complete survey of the subject from all aspects, including hot-water supply and cooking, using all available heat sources, and with information on relative capital and running expenses.

LOW PRESSURE HOT WATER SYSTEM

This is the system most widely used in this country. The water circulation is maintained throughout the system either by natural means, i.e., gravity, or with the assistance of a circulating or accelerating pump. The use of a pump should be reserved for cases where the extent or levels of an installation would entail the use of unduly large pipes without such assistance. Pumps should be installed in duplicate :—with one as a stand-by and should be located near the boilers. The heat distributing units are either standard radiators having column surfaces, or panels having plane surfaces consisting of lengths of piping, embedded in the structure and covered with plaster or other finish. Where panel heating is used in connection with suspended ceilings or other false surfaces, the heating panels should be in contact with the finished surface and be insulated at the back to prevent loss of heat. Radiators having plane surfaces are similar in operation to panels, but are usually planted on the surface. Standard radiators function mainly by convection (air movement), and only to a small degree by radiation ; panels mainly by radiation and only partly by convection. The extent of an installation and the sizes and capacities of its parts depend directly on the maximum loss of heat from the building. This loss is determined by the temperature at which the interior of the building is to be maintained during the times of minimum external temperature. The standard internal temperature in this country is about 60°F., but it is common to provide for one of 65°F., with an outside temperature of 30°F.

The following table indicates the internal temperatures suitable for various rooms, in degrees Fahrenheit :—

Places of Public Resort, e.g., Cinemas, Theatres and Dance Rooms ... ... (empty)	55
Schools	55–60
Bedrooms, Hospitals (General)	55
Living-rooms	60–65
Offices, Banks, etc.	60–65
Factories and Workshops (General)	55–65
Shops	60
Restaurants, Hotel Public Rooms	60–65
Beer and Wine Cellars (General)	52–54

STEAM HEATING

This is not used to any great extent in this country for buildings of the domestic or office types, but has a very considerable field in workshops and factories where in many cases steam must be provided for process work. Modern steam heating systems are operated at pressures very little above atmosphere, i.e., 1·5 to 3 lb. per sq. in., and with suitable regulating valves and steam traps are quite satisfactory. In the latest development, incorporating the use of a special vacuum return system for the condensed steam, sub-atmospheric pressures are used, allowing very close regulation and a wider range of surface temperatures.

CENTRAL HEATING BY WARMED AIR

By using a combined system of heating and ventilation, central heating may be effectively carried out. This type of installation is described under "Ventilation."

TEMPERATURES OF HEATING UNITS

The flow temperatures of water radiator systems are from 160° to 180°F. Those of Panel systems from 95° to 120°F.

COMPARISON OF BRITISH THERMAL UNIT WITH BOARD OF TRADE ELECTRICAL UNIT

The British Thermal Unit, or Heat Unit, generally abbreviated to B.Th.U. is frequently confused with the Board of Trade electrical Unit or Kilowatt Hour.

The former represents the standard used in this country by which the effects of heat transfer are measured, and is the quantity of heat required to raise the temperature of 1 lb. of water by 1°F., or, conversely, the amount of heat given up when 1 lb. of water cools through 1°F.

The Board of Trade Unit or Kilowatt hour is the standard by which the consumption of electrical energy is measured and charged in this country and is usually abbreviated to "Unit."

It represents the consumption of 1 kilowatt or 1,000 watts for one hour and its heating value expressed in B.Th.U. is 3,410 B.Th.U. approximately.

HEATING SURFACE REQUIRED

The amount of heating surface required when ceiling panels are installed is approximately the same as if standard type radiators were used under similar conditions. The emission rate from a panel heated surface is approximately 120 B.T.U. per hour per sq. ft. of panel area. From radiators the rate is approximately 150 B.T.U. per hour per sq. ft. of radiator surface. The comparative absence of convection effects, when panels are used, reduces the rate of air change, so that the lower emission rate provides an approximately equal warming effect to that given by radiators.

AIR CHANGES

The normal rate of air change in a room when standard radiators are installed is approximately two per hour : with panels, the normal change is at the rate of one-half to one per hour. If a definite rate of change is required in excess of these figures, ventilation must be increased and heating surface added to deal with the extra changes.

The following table indicates the number of air changes per hour allowed for in general practice and under normal conditions in the design of heating installations, using radiators :—

Rooms, with normal window area, and up to 15,000 cu. ft.	2
Ditto, over 15,000 cu. ft., and up to 25,000 cu. ft.	1½
Churches	1½
Offices	2–3
Hospital Wards	3–4
Open Air Class Rooms	3–9

RADIATORS

Radiators are usually placed under windows to minimise the effects of the down draught, and are most effective in this position.

Radiator Casings

Casings consisting of a top, front and two ends all of open mesh material (60 per cent void) restrict the transmission of heat by at least 15 per cent : those made of wood frames with open mesh fronts and solid tops by approximately 22½ per cent, and similar casings having solid fronts with narrow openings at top and bottom of front panel, and with solid tops, by 25 per cent and upwards, according to the area of the openings.

Effects of Paint on Radiators

The effective total heating output of a standard type of radiator is influenced by the character of the surface, but not to the extent usually attributed to this cause ; in small installations the extent is negligible. The surface influences the radiation factor only, and does not alter the convection factor ; and since convection provides the greater portion of the total output, a comparatively large radiation drop is necessary before the total output is materially affected. Taking "Dull Black" as the standard for comparison purposes, representing 100 per cent of possible output, the following figures represent the approximate percentage output for each type of paint or surface quoted :—

	per cent
Dull Black Paint	100
Non-Metallic paints, all colours	100
Bronze Paints, Aluminium, Gold, Copper with gum-varnished base	88
Bronze Paints, with two coats of copal varnish...	97
Bronze Paints, Cellulose base	82
Polished Steel	75
Polished Cast Iron	78
Polished Aluminium	75
Nickel-plated Iron	75

BOILERS

The cast iron sectional type of boiler is the one most commonly used for heating services and is perfectly satisfactory for buildings up to 100′ in height. In cases where the head on the boiler will be in excess of this figure, the makers should be consulted or an alternative type installed. Semi-steel and steel boilers are available and their makers will be prepared to state to what head any particular type may be loaded.

In large office buildings, public buildings and institutions there is frequently a demand for steam for kitchen or other purposes and in such cases a steam boiler, in conjunction with calorifiers, should be considered seriously for dealing with the general heating and hot water services.

Boilers may be heated with solid, liquid or gaseous fuels and may be controlled automatically by means of thermostats, fitted either in the boiler or calorifier, and/or in a typical room or space to be heated. In the cases of boilers using liquid or gaseous fuels, the thermostats operate to control the actual fuel supply to the boiler, and in the case of boilers using solid fuels, control the consumption by regulating the draught to suit the demand.

Labour Costs

The labour costs directly attributable to boiler attendance vary considerably. In many instances where complaint is made as to heavy charges in this respect, it has been found that the attendant could easily and conveniently deal with other work between firing and cleaning periods.

In this connection, stress is usually laid on the fact that oil-fired boilers require less attendance than those burning solid fuels. While it is correct to assume that such is the case, this does not mean that the services of the stoker or attendant may be dispensed with. It will, at least, be necessary to provide periodical supervision, and with large installations the attendant must be on hand during the time the boiler is in service. Generally, steam boilers require closer attention than hot water boilers.

Mechanical Stoking

Mechanical stoking devices have been in general use with large steam-raising boilers for many years, but until comparatively recently little attention has been given to the possibility of applying such equipment to the smaller types of boilers such as are fitted in the majority of buildings. There are now available several types of mechanical or automatic feeding arrangements, suitable for sectional and other small boilers.

These may be divided into two general groups—each able to deal with solid fuels—the first of which is on the mechanical stoker principle in that it feeds the fuel to the furnace by means of a worm-type conveyor driven by an electric motor or other suitable engine ; the second type being fitted with a storage hopper from which the fuel falls on to a specially designed grate by gravity, the rate of feed being directly controlled by the combustion.

The first type is most suitable for coal, which is more easily broken and less liable to jam the worm than coke, and it is claimed that this type of stoker will allow small and slack coals to be burned efficiently in the sectional type of boiler. The second type is more suitable for coke, as there are no moving parts. Very high efficiencies are stated to have been obtained with this equipment, using gas coke.

CALORIFIERS

Calorifiers or indirect heaters are usually of cylindrical section and are used where (*a*) it is required to heat water by means of steam, without direct contact between the two, (*b*) it is desired to combine heating and hot water services on one boiler system, and (c) where the water is " hard " and it is undersirable to circulate the primary supply through the piping to the fittings.

Calorifiers may be of the storage or non-storage type, the former heating the water as it circulates over or through the heating unit and the latter combining a storage cylinder with the calorifier, from which the demand may be met as and when required. The non-storage type is usually installed for heating services, and the storage type for hot water services.

Calorifiers consist of an outer shell in which is fitted a pipe coil, radiator or annular cylinder. The steam or hot water from the boiler passes through these, thereby heating the water in the body of the cylinder indirectly. In most cases there is sufficient temporary hardness in the water to necessitate periodical cleaning of the heating coil or radiator, and provision should be made for easy access to these units.

Steam heated calorifiers are generally controlled by means of a thermostat, the operation of which partly or wholly closes the steam inlet valve. Water-heated calorifiers, especially of the domestic type, are frequently controlled by hand alone ; but where a thermostat is used, this may either control the water inlet valve as already described, or in some instances the boiler temperature.

STANDARDS OF HEAT LOSS

Post-War Building Studies, No. 15, " Walls, Floors and Roofs " (H.M.S.O. Price, 9d. net), treats the subject of Thermal Insulation in detail and sets forth standards regarded as desirable.

Standard A.—For domestic buildings warmed by normal open type fires, gives a value of " U " as follows :—

External walls generally U = 0·30.
" " living-room U = 0·20.

Standard B.—For controlled heating appliances (slow combustion, electric or central heating).

External walls generally U = 0·20.
" " living-rooms U = 0·15.

U = number of B.Th.U. transmitted per hour through a sq. ft. of the construction when a difference of 1° F. exists between the air on the two sides.

Below is given a table of values of " U " for various types of construction. These figures are quoted from standard authorities :—

WALLS	" U "
4½" brick, unplastered	0·50
4½" " plastered inside	0·44
9" " unplastered	0·35
9" " plastered inside	0·33
14" " unplastered	0·27
14" " plastered inside	0·25
18" " unplastered	0·23
18" " plastered inside	0·22
22" " unplastered	0·20
22" " plastered inside	0·19
9" " with air space	0·29
14" " " "	0·23
18" " " "	0·20
9" " unplastered, lined ½" board	0·21
14" " " " " "	0·18
12" sandstone	0·46
18" "	0·36
24" "	0·30
12" limestone	0·55
18" "	0·45
24" "	0·38
4" concrete	0·57
6" "	0·48
8" "	0·41
10" "	0·36
12" "	0·32

CEILINGS

	"U"
Lath and plaster, with tiled roof over, rafters boarded one side only	0·24
As above, but rafters boarded both sides	0·18

ROOFS

	"U"
Flat roof, concrete and steel, laid with asphalt, concrete 6″ thick	0·28
Ditto, concrete 9″ thick	0·25
Ditto, concrete 11″ thick	0·23
Pitched roof, tiles on rafters, boarded one side ...	0·35
Ditto, boarded both sides	0·18

FLOORS

	"U"
Hollow Block Floors	0·25
R.C. Floor, laid with floor boards on battens, concrete 6″ thick	0·20
Joist floor, on sleeper walls, on 6″ concrete on earth	0·15
Concrete floor, 6″ thick, ¾″ screed and wood blocks	0·25
Ditto with concrete 12″ thick	0·20

GLASS

	"U"
Single Windows	1·03
Double Windows	0·50
Plate Glass Windows	0·75

The Institution of Heating and Ventilating Engineers publish a comprehensive pamphlet "The Computation of Heat Requirements for Buildings." Price 1s. 9d. post free, 2s. 0d. See special article "Structural Insulation of Dwelling Houses and Flats" on page 205.

ELECTRICITY FOR HEATING PURPOSES

Electric heating may be carried out by the use of electric fires, electrically heated water radiators, low temperature electric ceiling or wall panels (embedded or on the surface) or thermal storage vessels using water or oil as the storage medium.

For constant heating service, electricity should not be used without thermostatic control, which will cut off the supply when the predetermined temperature is reached in the rooms or spaces served. This condition eliminates the use of electric fires for constant heating, but any of the other systems may be placed under automatic control and are in general use in this way. From observations taken over a period of years and seasons of varying severity, it has been found that for rooms of normal construction 750 to 1,000 watts are required per 1,000 cu. ft. of space, and each 1,000 watts will be in use for 750 to 1,000 hours during a complete heating season. This equals a consumption of 750 to 1,000 kilowatt hours or Board of Trade Units per 1,000 cu. ft. and it is on this basis that comparative costs of different types of fuel may be calculated.

Each Kilowatt hour or Unit has a heating value equal to 3,410 B.Th.U.'s, and it may be taken that the efficiency of electrical heating is about 100 per cent, as there are no flue or similar losses such as occur with the use of solid or liquid fuels, although in the case of a thermal storage equipment there will be radiation losses from the tank or boiler, as would be the case with a coke or oil-fired boiler.

COMPARISON OF FUEL COSTS

Assuming a case in which it is desired to consider the use of electricity for heating a building, based on the question of fuel costs, these may be determined approximately as follows :—

Electricity at 1d. unit
Calorific value of one unit ... = 3,410 B.Th.U.

Assuming Gas at 14d. per therm of 100,000 B.T.U., and the overall efficiency of a Gas-fire Boiler at 75 to 80 per cent then 1d. will provide about :—

$$\frac{100{,}000 \times \cdot 75}{14} = 5{,}350 \text{ B.Th.U.}$$

Coke at 78s. 0d. per ton, calorific value 12,000 B.Th.U. per pound
1d. will provide about 2·39 lb. of coke
The overall efficiency of a coke-fire installation hand-fed is not much over 50 per cent, so 1d. will provide 2·39 × 12,000 × ·5 ... ... = 14,340 B.Th.U.
Oil Fuel costs about 75s. 0d. per ton, calorific value 19,000 B.Th.U. per lb. 1d. will provide about 2·44 lb. of oil
Assuming the efficiency at the same value as for the coke-fired boiler, 1d. will provide 2·44 × 19,000 × ·5 ... ... = 23,180 B.Th.U.

(In practice, due to the closer control possible with oil fuel burners, a higher efficiency may be looked for, bringing the relative costs of oil and coke closer.)

Other considerations usually influence the choice of fuel to be used, such as delivery of fuel and removal of ash, the difficulty of providing boiler-house space and fuel storage, the desirability of omitting a chimney, and so on ; and it is seldom that fuel costs alone are the sole factors to be considered.

References :

P.W.B.S. No. 19 "Heating and Ventilation of Dwellings." H.M.S.O., 1945. 2s. 6d.

CHIMNEYS AND FLUES

Both in London and (practically everywhere) in the Provinces, details of construction are controlled by byelaws, made (as the case may be) by the L.C.C. or by the local authority.

Note.—Outside London reference should be made to the local byelaws, to ascertain what (if any) legal requirements are in force on this subject.

Requirements in London are set out in Byelaws 119 and 132 to 136, made under the London Building (Amendment) Act, 1935. These should be consulted for detailed provisions.

BOILER CHIMNEYS

The following table of flue sizes has been found to give satisfactory results with normal conditions and up to a height of 700 ft. above sea level :—

Flue Area (Sq. In.)	Height in Ft.				
	20	30	40	60	80
	British Thermal Units per hour				
81	190,000	220,000	270,000	340,000	—
126	320,000	380,000	430,000	500,000	650,000
196	400,000	550,000	750,000	850,000	1,000,000

CHURCHES

Reference :

Pamphlet "Architectural Requirements and Suggestions." Price 6d. net., giving full information is obtainable from the Queen Anne's Bounty Offices, 3, Dean's Yard, S.W.1.

CIRCLES, AREAS, etc.

(See " Mathematical Data.")

CLOAKROOMS

Modern equipment of cloakrooms in schools and similar institutions may consist of metal racks arranged in island sites providing freedom of access to the sides and ends, the hooks being fixed to horizontal rails. Where necessary, additional rails are provided, bracketed out from the wall face to avoid contact between the coats and the wall. Where the accommodation is restricted by cost or area available, the horizontal rails are arranged two tiers high with the hooks spaced hit-and-miss fashion on plan to give individual spacing to each hook. It is, however, desirable to fix the rails singly in height, thereby preventing any overlapping of hanging garments. The hooks are numbered and fixed on both sides of the rail, or tubular bar, with galvanised wire-mesh mounted vertically on the centre line of each bay to prevent the clothes on one side touching those on the other. It is not desirable to utilise the heating pipe as rack supports owing to the risk of leakage. The safe method is to provide independent pipes at floor level, and at a high level. Through ventilation is essential for cloakrooms and is usually provided by window openings or louvred ventilators on at least two sides of the room.

ELEMENTARY SCHOOLS

	Two rows hat and coat rails Height of rail	Hooks Spacing
Infants, girls	3′ and 4′ high	18″ centres
Infants, boys	,, ,, ...	12″ ,,
Girls	3′ 6″ and 4′ 6″ high ...	18″ ,,
Boys	,, ,, ...	12″ ,,

Note.—The spacing may be reduced where one row only is used.

Gangway width between hanging rails should be at least 4′.

SECONDARY SCHOOLS INCLUDING COUNTY SCHOOLS AND COLLEGES

One hat and coat rail only, 4′ 6″ high in all cases.

Girls ... Hooks spaced at least 12″ centres.

Boys ... Hooks spaced at least 10″ centres.

Spacing of island racks with seat lockers 4′ 6″ centres.

LOCKERS (STEEL)

The usual stock sizes of steel lockers are given in the following table :—

Type	Height (Inches)	Width (Inches)	Depth (Inches)
Single tier			
General employees (Office buildings, etc.)	76	12	12
Ditto ditto	76	12	15
Ditto ditto	76	15	15
Ditto ditto	76	18	18
Double tier			
Factories, colleges and schools ...	76 (each 36′ high)	12	12
Ditto ditto	ditto	15	15
Four tier			
Factories, colleges and schools ...	76 (each 18′ high)	15	15
Double tier			
Golf lockers	102	12	12
Single tier			
Golf lockers	51	12	12

There is some variation in detail and size between the products of various makers.

COMMUNITY CENTRES

Reference :

Articles by " E. and O.E." in " The Architect and Building News," November 15th, 1946 to February, 1947. These deal comprehensively with the planning of village halls and urban community centres.

See also : " Village Halls and Social Centres in the Countryside," National Council of Social Service, 26, Bedford Square, W.C.1, 1945. 3s. 6d.

" Community Centres," by F. and G. Stephenson. Housing Centre, 1942. 3s. 6d.

Ministry of Education : " Community Centres." H.M.S.O., 1944. 9d.

CODES OF PRACTICE

See list on p. 177.

CONCRETE

Concrete is made with Portland cement or hydraulic lime, sand and aggregate. The size and nature of the aggregate vary according to the nature of the work. Lime concrete is made with grey stone lime or blue lias lime.

NOTES ON TESTING AGGREGATES

In all concrete work it is advisable to test the sand and gravel for the presence of clay or loam, lime (including sea-shell, etc.), organic matter or other deleterious substances.

The test methods are now standardised, and reference should be made to B.S. 812 : 1943 for full descriptions of sampling and test methods. For rough site estimation the following methods may be useful :—

(1) Make a 3 per cent solution of caustic soda and water (distilled if possible) ; fill the bottom 2 or 3 in. of a glass jar with a fair sample of the aggregate to be tested and pour in sufficient of the solution to cover it. Thoroughly mix by shaking the jar, afterwards allowing it to stand for at least 1 hour. If the solution becomes claret or red coloured, there is organic matter present and the sand or gravel should be rejected. A light straw colour indicates that the material is safe to use.

(2) Put a fair sample of the aggregate into a glass jar and add clean water until the water stands about three in. above the level of the material. Thoroughly mix the contents by shaking the jar, then allow the latter to stand until everything has settled. The clay or loam will be seen as a coating on the top of the material. If there is excessive clay or loam present, the sand is unfit for reinforced concrete work.

Note.—The above two tests are of no use where the aggregate has a coating of clay or similar substance which is not removable by washing. Such a coating destroys the bonding action between the aggregate and the cement.

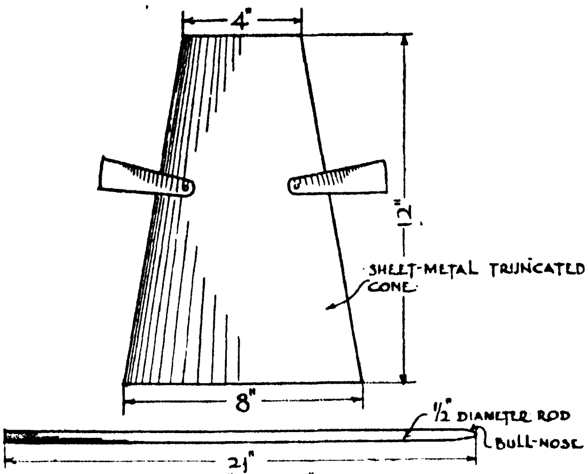
CEMENT TESTS

Test procedures for sampling cement are described in B.S. 12 : 1940, for ordinary and rapid hardening cements, and in B.S. 915 : 1940 for high alumina cements. Test certificates are often required in specifications, and should always be obtained from the manufacturers in the case of large consignments.

Rough and ready site tests are of little use in estimating the quality of cements.

SLUMP TEST FOR WATER CONTENT

Concrete containing an excess of water has a much lower ultimate strength than concrete mixed with the least possible amount of water sufficient to give the plasticity necessary for the work in hand.



APPARATUS FOR "SLUMP" TESTING

The test is made by means of a truncated cone of sheet metal (with handles at sides) and a ½" diameter bullnosed rod 22" long (see sketch). This mould is placed on a non-absorbent surface and filled to a depth of 4" with the wet mix, which is consolidated by puddling with the rod—25 strokes being given. A second depth of 4" is then filled and consolidated as before, the puddling going only to the depth of the first filling. The remainder of the mould is filled in a similar manner and the top levelled off. The mould is left for three minutes, then lifted off and placed beside the test piece, which will have settled or "slumped." The extent to which this settlement has taken place is measured in inches, and described as "so many inches slump." By working to a definite slump variations in water content, and thus in strength, will be eliminated. As the consistency of the concrete is different for various types of work, the following maximum slumps are suggested, these being based on average aggregates and proportions, and assuming that the aggregates contain the same degree of moisture that they will have when supplied to the mixer.

Type of Concrete	Maximum Slump in in.
Mass Concrete	2
Reinforced Concrete :—	
(1) Heavy Sections	2
(2) Thin vertical sections and columns	6
(3) Thin confined horizontal sections	7
Concrete Roads—Surfacing	1

CONCRETE ROADS

The concrete mix for road construction varies between the limits of 1 : 1 : 2 and 1 : 4 : 8, the former for a heavy volume of traffic and the latter for light.

The thickness of concrete to be used is governed by the bearing power of the soil and the volume and weight of traffic to be carried. It is advisable to keep all roads to a minimum of 6" thickness whatever the use. If the ground is of low bearing power, reinforcement should be placed near the underside of the concrete with sufficient cover to give adequate protection to the steel. In this case the concrete mix should be at least 1 : 2 : 4. Where very heavy traffic may be expected, a layer of reinforcement should be placed in the top side of the concrete in addition to that in the under side and a rich mix of concrete used.

All soils carry weights more adequately if drained, and a layer of clinkers under the concrete, therefore, is advantageous. Concrete contracts when drying and expands under heat and wetness. The former is the larger, being about ⅛" in 50'.

Joints should be made to allow for expansion and contraction, these being placed so that the panel concreted can be completed in a day's work.

Usually the panel size is 15' broad by 50' long. These panels should be constructed alternately and the joints between filled with bitumen. Joints can be made at right angles to the flow of traffic or at such an angle with the kerb, that only one wheel passes over at a time. A long straight edge should be used to ensure the joints being of a smooth top surface, especially on gradients.

The whole surface of the concrete should be finished off with a wood float or finishing tool to an even, but not too smooth, surface and kept wet for three weeks. Slump tests of the concrete should be made frequently. It is recommended that the mix should not be very wet but just sufficiently so to give a slump not exceeding 1½".

The normal camber of a concrete road should be about 1 in 40, and where curves are encountered super-elevation should be considered, a cross fall of 1 in 24 giving reasonable results.

TREATMENT OF SURFACES WITH SILICATE OF SODA

1. Allow surface to dry and time for concrete to be well cured.
2. See that concrete surface is thoroughly clean before application.
3. Mix 1 gallon of silicate of soda with 4 gallons of water.
4. Apply mixture to cleaned and dry surface with soft brush or mop.
5. After surface has been allowed to dry (approximately 24 hours) apply further coat or coats until no more of the mixture can be absorbed, generally about 3 coats.

Note.—(*a*) 1 gallon of silicate of soda will treat about 40 sq. yds.

(*b*) When ordering silicate of soda it is necessary to ensure that the correct proportion of silicate is obtained ; therefore state the purpose for which the silicate is required.

CELLULAR CONCRETE

The advantages which are usually claimed for cellular concrete are (1) economy in weight and (2) excellent thermal insulation. It may be noted that as a general rule these two properties go together. Saving of weight becomes important in material to be used for partitions, casings for beams and stanchions and for panel infilling and screedings generally. A cellular or lightweight structure, containing an abundance of air voids, is likely to afford good heat insulation but will not necessarily be of value in reducing the transmission of sound, since, in homogeneous materials, mass and rigidity are the properties most conducive to good sound insulation. In this connection, reference should be made to the Building Research Board publication, Bulletin No. 14, "The Reduction of Noise in Buildings : Recommendations to Architects," and to P.W.B.S. No. 14, "Sound Insulation and Acoustics," H.M.S.O., 1944, 1s. 0d.

Cellular concrete is prepared in various ways of which the following are the more important :—

1. By the use of an aggregate itself having a cellular structure. Pumice, breeze and clinker concretes are the most important in this class.
2. By elimination of all the fines from a concrete made with a porous or non-porous aggregate. In this way an open structure is obtained with a high proportion of larger air voids.
3. By chemical reaction of an addition made to a cementing material which sets up a frothing action due to gas evolution whilst the mix is plastic.
4. By agitating a cementing material in the plastic state with a foam-forming agent. In this class of material the foam produced by agitation of the wet mix remains stable until the cementing material has formed a rigid structure.

Aggregates

Lightweight concretes of the type produced from cement and a porous aggregate are used in precast units and for in situ work. Of this class those made from breeze and clinkers are by far the cheapest. With concretes made of these aggregates there is the danger of obtaining unsound material, causing expansion and subsequent " blowing " of surfacing materials. Lightweight aggregates should therefore always be specified to comply with B.S.S. 877 : 1939 for foamed blast-furnace slag, 1047 : 1942 for coarse blast-furnace slag, or 1165 : 1944 for clinker, aggregates respectively. Concretes with such types of coal and destructor residues may exert a deleterious action on embedded steel, pipes, conduits, etc., and serious corrosion may be set up. Pumice aggregates are considerably more expensive than breeze or clinker aggregates. So far as is known, however, they are not likely to be unsound and should not be liable to failures of the type associated with unsound breezes and clinkers, nor do they exert a corroding influence on embedded steel. In the use of such aggregates, however, where embedded steelwork is to be covered or protected, it has to be considered whether in fact a porous aggregate is capable of preventing access to the embedded steel of deleterious agencies, of which air and moisture are the most important.

Shrinkage

Apart from considerations of strength attached to the use of concretes made with any of these lightweight aggregates—such concretes provide, at the most, crushing strengths about one-third that of normal ballast concrete—the most serious difficulty which arises in the use of any of these materials is their drying shrinkage, which is much greater than that of normal ballast or gravel concrete. The moisture movement of normal pumice concrete is about double that of normal ballast concrete and comparable with that of a sound clinker concrete. This drying shrinkage is of particular importance in works where it is desirable to avoid the formation of shrinkage cracks, and special precautions are often necessary to overcome this inherent property of concretes formed of lightweight aggregates. It should be noted that shrinkage is to a large extent influenced by the proper maturing of the product.

No-Fines Concrete

The properties of cellular concrete of type (2) above, made with aggregates porous or otherwise, but with fines eliminated so that the main part of the air void space is due to unfilled cavities between the larger aggregate, are rather different from those of the other types of concrete. It has a special application in external wall construction, since, owing to its structure with large voids, capillary effects are minimised. Such a material demands some sort of weather protection, i.e., rendering or roughcast, but in the event of cracks appearing in the protective coat a wall would not be likely to become saturated due to penetration of moisture through the cracks.

Foamed Concretes

Lightweight concretes, in which the cellular structure is produced by foam-forming methods described in types (3) and (4) above, may consist of neat cement or with the addition of fine aggregate, usually sand, and are available in precast block or for in situ work. For the protection of embedded steel a concrete structure of this type comprising disconnected cells is likely to be the more useful, provided, as always, the concrete is not one which is excessively prone to shrinkage crack formation. Though, generally, concretes of this type have shrinkage movements in excess of the normal ballast concrete, it is possible to obtain a mix by the stable froth method with a moisture movement comparable with ballast concrete. Before this is possible, however, it requires a lean mix yielding a concrete weighing about 75 lb. cu. ft. as against normal gravel concrete of 140 lb. cu. ft. and, again, careful maturing is necessary to obtain this result. In the use of these cellular concretes, the minimum crushing strength necessary for the work must also be given consideration ; the maximum crushing strength obtainable from concretes of this class is about one-fourth that for normal ballast concrete, and this figure is obtained only from the leaner mixes in which the sand content and consequently the weight, is greatest.

In the following table is given some indication of the range of weights and thermal conductivities of the different types of lightweight concretes. The figures given are more for the purpose of indicating the relationships than for statements of absolute values.

Material	Weight lb./cu. ft.	Thermal Conductivity U B.T.U./sq. ft./hour/1" thickness/1°F. difference in temperature
Breeze Concrete ...	50–75	2·1 – 4·5
Clinker Concrete ...	70–100	5·0 – 9·0
Foamed Slag 1 : 3 : 6	70–90	1·7 – 1·9
Pumice Concrete ...	40–58	1.28– 2·7
Cellular Concrete :—		
Neat cement ...	12–31	·3 – ·8
1 cement, 1 sand ...	31–63	·8 – 1·8
1 cement, 4 sand ...	56–83	1·6 – 3·0
Gravel Concrete ...	130–150	8·0 –12·0
Brick	110–130	5·0 – 9·0

From general data available it may also be taken that in any series of concretes made from any one form of cellular aggregate or of one cellular structure :—

(*a*) The increase in thermal insulation is inversely proportional to the weight per cu. ft. of the concrete, i.e., the greater the weight the less the resistance of the material to the passage of heat.

(*b*) The weight per cu. ft. of the concrete is directly proportional to the crushing strength, i.e., the lower the weight the lower the strength.

(*c*) The weight per cu. ft. of the concrete is indirectly proportional to the percentage change in moisture movement, the lower the weight the greater the shrinkage.

COLOURED CEMENTS AND CONCRETES

Coloured cements and concretes may be obtained either by the use of naturally coloured sands and aggregates or by the addition of dry powder colours to the mix. Dark grey, purple, red and green sands are available in addition to the common yellow and cream varieties, and further colours can often be obtained by heating or roasting the common yellow sands, which in some cases turn red, orange or grey by this means. In the selection of such special materials care should be taken to see that they are suitable for use with cement before the work is commenced. The decorative effect of concretes formed of coloured aggregates can be increased by removing the cement, either by chiselling or bush hammering the surface or by treating the surface of the shuttering with one of the proprietary retarders, which will allow the surface cement to be brushed off easily after the removal of the form-work, thus exposing the aggregates.

Where actual pigments are added it is desirable, particularly in renderings, to use sands as nearly as possible of the same colour as the finished work. Where there is considerable difference in colour it will be necessary to bring to the surface a great deal of the colouring matter, and with it the fine cement or laitance, in order to mask the colour of the aggregate. Such fatty surfaces are more likely to craze than are the lean sandy faces produced by a skilful plasterer using a wooden float.

Great care should be taken in setting out the work in any important scheme to be finished with a decorative rendering, as it is difficult even with the best labour to make the junction between one day's work and the next entirely invisible. Joints should, where possible, follow the lines of string courses and similar breaks in the surface level.

Surface washes of coloured cements can be sprayed upon existing renderings or other wall surfaces, and finished either with a matt or semi-glossy surface. A white cement slurry can also be brushed on in lieu of limewash, but care should be taken when this is to be done over old limewash, as the natural tendency of the latter to flake may be accentuated.

CONCRETE PROPORTIONS

The following are suitable proportions for portland cement concrete :—

	Cement	Sand	Coarse Aggregate	Size of Aggregate
For ordinary mass concrete foundations ...	1	3	6	2″
For first quality mass concrete foundations	1	2½	5	1½″
For general reinforced concrete	1	2	4	¾″
For special reinforced concrete	1	1½	3	⅜″–¾″
For extra special reinforced concrete ...	1	1	2	⅜″

REINFORCED CONCRETE

(See pamphlet " Materials and Workmanship for Reinforced Concrete " issued by the Institute of Structural Engineers. 1s. 8d. post free).

Sand.—(Fine aggregate). This should pass a $\frac{3}{16}$″ square mesh and at least 90 per cent should be retained on a sieve having 40 meshes to the linear inch, and should be well graded throughout these limits. Sea sand should be used with the utmost caution, as it is often too fine or full of minute organic life or of shell particles, while the presence of salt favours efflorescence.

Coarse aggregate.—This should pass a ¾″ square mesh and be retained on a $\frac{3}{16}$″ square mesh, and vary in size as much as possible between these limits. For structures to contain liquid, or exposed to liquids, the aggregate should be non-porous. Aggregates containing any of the following materials should not be used : Coke breeze, cinders, clinker, blast furnace slag, clay, and sulphates such as plaster of Paris. Broken brick should be used only with extreme caution.

Water.—The water used in concrete should be free from all impurities, and when the correct amount for each batch of concrete is ascertained (by slump test), a suitable tank should be provided to ensure correct gauging.

Steel Reinforcement.—The mild steel reinforcement must comply with B.S.S. 785 : 1938 or 1144 : 1943.

Hooks should be bent cold and of an internal diameter equal to four times that of the rod.

Formwork.—The contractor should be responsible for the sufficiency of the formwork and should supply secure braces to prevent bulging and sagging during construction. Wedges, clamps and bolts should be used wherever possible. Where concrete is laid at an angle exceeding 30° with the horizontal, it should be shuttered on its top surface.

Construction Joints.—All construction joints should finish square (not ragged). In floor slabs and beams where stoppage of work is unavoidable, the break should be at right angles to and along the centre lines of the span. " T " beams or " L " beams, where concreted separately from the slabs, should be stopped 1″ below the soffit of the latter. In long walls, vertical construction joints at equal intervals serve also as expansion joints. The concreting of columns should stop not less than 1″ below the lowest point of any connection, at the point of junction with the column. Stop boards should be rigidly fixed and slotted to allow the passage of the reinforcement.

Day-Work Joints

It is essential that the joints between one day's work and the next should be treated carefully, both to preserve the appearance of the work and to ensure its freedom from trouble at such points.

A layer of grout or slurry often forms on the surface of the old work, and it is essential that this layer, with the skin just below it, be removed to expose a surface of good concrete before fresh concrete is applied.

Removal of Shuttering

A rough guide to show whether form-work may be removed is obtained by striking the concrete in some accessible place with a hammer. If the hammer rebounds with a ringing sound it is generally safe to remove the shuttering. This operation must be carried out slowly and with the minimum of wrenching. Unless the specification states otherwise, the time for the removal of shuttering may be taken from the following table :—

Part of the Structure	Ordinary Portland Cement	Rapid Hardening Cement
Walls, beams, sides and columns	4 days	2 days
Slabs (re-shored)	6 days	2 days
Shores to slabs	14 days	7 days
Beam Bottoms (re-shored) ...	12 days	4 days
Shores to Beam Bottoms ...	28 days	14 days

LONDON REINFORCED CONCRETE CODE

The following is a summary of parts of the code of reinforced concrete design adopted in the form of byelaws by the L.C.C. This code differs in some respects from that advocated by the Building Industries National Council. See also P.W.B.S. No. 8, "Reinforced Concrete Structures" (H.M.S.O., 1944. 6d.)

GENERALLY

Reinforced concrete to be not inferior to the composition and quality designated III in byelaw 14 (i.e., 1 cwt. cement, 2½ cu. ft. fine aggregate ; 5 cu. ft. coarse aggregate).

Cover to Reinforcement (exclusive of plaster or other decorative finish).

Location of reinforcement	Minimum cover
Longitudinal rods in beams	Not less than 1″ or less than the diameter of rod.
All rods in slabs.	Not less than ½″ or less than the diameter of rod.
Longitudinal rods in columns	Not less than 1½″ or less than the diameter of rod.
Any other reinforcement (except where used as binding).	Not less than ½″ or less than the diameter of rod.
Ends of rods not anchored by a hook.	Not less than 2″ or less than twice the diameter of the rod beyond its anchorage.

LIMITING SIZES OF REINFORCEMENT

No rod shall exceed 2″ in diameter.

Minimum diameter of longitudinal reinforcement in columns, not less than ½″.

Minimum diameter of main reinforcement in beams or slabs, less than ¼″.

The minimum diameter of reinforcement other than longitudinal rods in a column or main reinforcement in beams and slabs and of steel forming a tie, helix, stirrup or the like shall not be less than 3/16″.

Where mesh reinforcement is used to resist tension the diameter of the steel shall not be less than 1/10″.

SPACING OF REINFORCEMENT

The distance between rods shall not be less than the greatest of the three following distances :—

(*a*) The diameter of either rod if their diameters are equal.
(*b*) The diameter of the larger rod where the diameters are unequal.
(c) ¼″ more than the greatest size of the coarse aggregate in the concrete.

Provided that the vertical distance between two main horizontal rods or the corresponding distance at right angles to two inclined main rods shall not be less than ½″ except at the splice and except where one rod is transverse to another.

DISTRIBUTION RODS IN SLABS

Where a reinforced concrete slab spans in one direction distribution rods must be placed on top and at right angles to the main rods, and of an aggregate area of not less than 1/10 the area of the main rods. The pitch of the distribution rods shall not exceed four times the depth from the top of the concrete face to the centre of the steel.

PERMISSIBLE STRESSES IN REINFORCED CONCRETE

The calculated compressive, shearing and bond stresses in reinforced concrete shall not exceed those set out in the table below.

Designation of Concrete	Modular Ratio	Permissible concrete stresses (lbs. per sq. in.)			
		Compression		Shear	Bond
		Due to bending	Direct		
Ordinary Concrete					
I	15	975	780	98	125
II	15	850	680	85	110
III	15	750	600	75	100
Quality A Concrete					
Ia	15	1,280	1,000	125	150
IIa	15	1,100	880	110	135
IIIa	15	950	760	95	120

Where other proportions of fine to coarse aggregate are used the permissible concrete stresses shall be based on the ratio of the sum of the volumes of fine and coarse aggregate (measured separately), to the quantity of cement and shall be obtained by proportion from the two nearest designations. For rods with tensile stresses induced by bending action the calculated bond stress due to a variation in the tensile stress shall not exceed twice that given for each designation of concrete.

SHEAR REINFORCEMENT

"Punching" shear in footings or similar construction shall not exceed twice that shown as appropriate for each designation of concrete in the above table. Where the concrete alone is not sufficient to resist the shearing action, the whole of this shearing action shall be provided for by the tensile resistance of the shear reinforcement acting in conjunction with the compressive resistance of the concrete. The maximum shear so provided for shall not exceed four times that which the concrete alone could resist under the byelaws.

COMPRESSION REINFORCEMENT

Where compression steel reinforcement is used in conjunction with the compressive resistance of the concrete, the rods must be adequately anchored at points not exceeding 12 times the diameter of the rod apart.

Where the concrete is not considered, the compressive reinforcement must be effectively anchored laterally and vertically at points not farther apart than eight times the diameter of the rods and the bindings shall pass round or be hooked over both the compression and tensile reinforcement.

PERMISSIBLE STRESSES IN REINFORCEMENT

The tensile and compressive stresses in steel reinforcement shall be calculated and shall not exceed the following stresses or those obtained under the bye laws relating to column design.

Designation of stress in steel rods	Maximum permissible stress in lb. per sq. in.
Tension in helical reinforcement in a column	13,500
Tension other than helical reinforcement in a column	18,000
Longitudinal compression in a beam where the compressive resistance of the concrete is not considered ...	18,000
Where the compressive resistance of the concrete is taken into account	The calculated compressive stress in the surrounding concrete multiplied by the modular ratio

REINFORCED CONCRETE COLUMNS

The effective column length to be assumed in determining the working load per sq. in. shall be as follows :—

Type of Column		Effective column length
Columns of one storey	Properly restrained at both ends in position and direction	0·75 of the actual column length
	Properly restrained at both ends in position but not in direction	Actual column length
	Properly restrained at one end in position and direction and imperfectly restrained in both position and direction at the other end	A value intermediate between the actual column length and twice that length depending upon the efficiency of the imperfect restraint
Columns continuing through two or more storeys	Properly restrained at both ends in position and direction	0·75 of the distance from floor level to floor level
	Properly restrained at both ends in position and imperfectly restrained in direction at one or both ends	A value intermediate between 0·75 and 1·00 of the distance from floor level to floor (or roof) level, depending upon the efficiency of imperfect restraint
	Properly restrained at one end in position and direction and imperfectly restrained in both position and direction at the other end	A value intermediate between the distance from floor level to floor (or roof) level and twice that distance, depending upon the efficiency of the imperfect restraint

PERMISSIBLE STRESSES IN COLUMNS

Where the ratio of effective length to least radius of gyration exceeds 50, the maximum permissible stresses shall not be greater than those obtained by mutliplying the appropriate maximum permissible stresses previously specified by the appropriate coefficient for each ratio shown in the following table :—

Ratio of effective column length to least radius of gyration	Coefficient
50 or under	1·0
60	0·9
70	0·8
80	0·7
90	0·6
100	0·5
110	0·4
120	0·3

Other values may be found by proportion but no reinforced concrete column shall have a ratio of effective length to least radius of gyration which exceeds 120.

REINFORCEMENT FOR COLUMNS

The cross-sectional area of longitudinal reinforcement in columns must not be less than 0·8 per cent and not more than 8·0 per cent of the gross cross-sectional area of the column. Where a column has helical reinforcement it shall also have at least six longitudinal rods within and in contact with the helical reinforcement and equidistant around its inner circumference.

Splices to longitudinal reinforcement shall overlap at least 24 diameters of the upper rod or sufficient to develop the force in the rod by bond whichever is the lesser.

LINKS IN COLUMNS

Reinforced concrete columns shall have transverse or helical reinforcement sufficient to provide against the buckling of the longitudinal rods, and such transverse reinforcement shall have a diameter not less than ¼″. The pitch of the transverse reinforcement shall not exceed the least of the following three distances :—

(*a*) The least lateral dimension of the column.

(*b*) 12 times the diameter of smallest longitudinal rod in the column.

(*c*) 12″.

Where helical reinforcement is used the pitch of the turns shall not exceed 3″ or more than one sixth of the core-diameter of such a column, and not be less than 1″ or three times the diameter of the steel forming *the helix*.

DIGEST OF L.C.C. MEMORANDUM ON THE COMPUTATION OF STRESSES IN REINFORCED CONCRETE STRUCTURES

Weight of reinforced concrete.—This may be taken as 144 lb. per cu. ft.

Effective span.—The effective span of beams and slabs should be taken as either :—

(1) The distance between centres of supports.

(2) The clear distance between the supports plus the effective depth of the beam or slab.

T-Beams and L-Beams

The breadth of flange assumed as taking compression should not exceed the least of the following in T-beams :—

(1) One third the effective span of the T-beam.

(2) The distance between the centres of ribs of the T-beams.

(3) 12 times the thickness of the slab plus the breadth of the rib.

In L-Beams

(1) One sixth the effective span of the L-beam.

(2) The breadth of the rib plus one-half the clear distance between ribs.

(3) 4 times the thickness of the slab plus the breadth of the rib.

In the portion of the slab considered as the flange of a T-beam or L-beam reinforcement should be provided transverse to the beam and across the full width of the flange. Where the slab spans independently in the same direction as the beam this reinforcement should be placed near the top surface of the slab.

Bending Moments in Beams and Slabs

In continuous beams or slabs the moments to be provided for should be the maximum positive and negative moments for the following arrangements of superimposed loading :—

(1) Alternate spans loaded and all other spans unloaded.
(2) Any two adjacent spans loaded and all other spans unloaded.

Beams and Slabs Spanning in One Direction

In this case the bending moments may be calculated on one of the following assumptions :—

(1) Beams monolithic with the columns should be designed with due regard to fixity and the resistance of the column to bending.
(2) Where beams and slabs are monolithic they should be considered as continuous over intermediate supports and capable of free rotation at supports. Beams monolithic with external columns (or others similarly loaded) should be designed for a negative bending moment equal to the sum of the bending moments in the upper and lower columns.
(3) The total bending moments in all cases of uniformly distributed loading over a number of approximately equal spans may be assumed to be as follows :—

Near Mid span end bay	Support next to end support	Midspan interior bay	Supports interior bays
$+\frac{WL}{10}$	$-\frac{WL}{10}$	$+\frac{WL}{12}$	$-\frac{WL}{12}$

Two spans may be considered as approximately equal when they do not differ by more than 15 per cent of the longer.

Shear

(Beams and slabs)

S = Total shearing force across a section.
s = Shear stress per sq. in. at any cross-section.
b = Breadth of a rectangular beam or rib of T-beam.
a = Lever arm of the moment of resistance.

The shear stress at any cross-section of a beam or slab is given by :—

$$s = \frac{S}{ba}$$

Where the calculated shear stress exceeds the permissible shear stress for the concrete the whole of the shear stress should be taken by tensile resistance of shear reinforcement in conjunction with the induced compression in the concrete. Even with such shear reinforcement the total shear stress should not exceed four times the permissible shear stress on the concrete alone.

Inclined Rods

Where tensile reinforcement is inclined and carried through a depth of beam equal to the lever arm it may be considered as shear reinforcment provided it is effectively anchored. The shear resistance of any section reinforced with inclined rods may be calculated on the assumption that the rods form the tension members of one or more single systems of lattice girders in which the concrete forms the compression members. The total shear resistance may then be taken as the sum of the vertical components of tension and compression forces cut by the section.

Vertical Stirrups

Spacing centre to centre not to exceed a distance equal to the lever arm.

The spacing should be calculated from :—

$$\text{Spacing} = \frac{As \times fs \times a}{S}$$

Where As = area of the cross-section of both legs of the stirrup.
fs = permissible tensile stress in the steel.
a = lever arm.
S = total shear at the cross-section.

TYPES OF CONCRETE AND PERMISSIBLE STRESSES

BYELAW 9

Aggregate

This shall be sand and gravel or crushed natural stone reasonably clean and free from clay, organic matter, coal, and coal residues (including clinker, ashes, coke-breeze, slag, and other similar material), dross, soluble sulphates (including gypsum and other similar material), porous and other material liable to reduce the strength of the concrete or to attack the steel reinforcement.

Fine aggregate

To pass through a $\frac{3}{16}$" mesh and not more than 5 per cent by weight shall pass a No. 100 mesh.

Coarse aggregate

To be of such a size as it will be retained on a $\frac{3}{16}$" mesh and to pass a mesh one quarter of an inch less than the minimum lateral distance between the reinforcing bars.

Aggregate to be graded

The fine and coarse aggregate to be so graded between the limits as to make a dense concrete conforming to the specified proportions and of a consistence that will work readily into position without the use of an excessive water content.

BYELAW 10

Plain concrete aggregate

The aggregate for plain concrete shall be as above specified or of hard well-burned brick or tile, pumice or other material approved by the district surveyor and shall be so graded and contain sand in such proportions as to produce a dense concrete.

Sand

To be clean and hard and reasonably free from clay, animal or vegetable or bituminous matter, and the grains to pass through a $\frac{3}{16}$" mesh.

BYELAW 12

Cement

The cement shall be Portland, Portland Blast Furnace, or High Alumina cement, but two of such cements shall not be used in combination.

Cement shall not be moved or disturbed after one hour from the time it has come into contact with water until it has set hard.

BYELAW 13

Water

This shall be clean and free from deleterious matter.

BYELAW 14

Concrete

This shall consist of aggregate mixed with cement. The proportion of fine aggregate to coarse aggregate is generally

to be taken as 1 to 2 by volume unless otherwise permitted. The concrete mixes are graded in main categories namely: "Quality A Concrete" and "Ordinary Concrete," (concrete for foundation and sites, and concrete used for other purposes than the actual construction of buildings such as filling voids and cavities on sites).

The grade "Ordinary Concrete" applies to mixes Nos. I, II and III, only. Mixes Nos. IV and V are used for such purposes as foundations and sites (i.e., rafts) and mixes Nos. VI and VII for filling cavities and voids on sites or similar purposes.

Designation of Concrete	Cu. ft. aggregate per 112 lb. cement		Minimum resistance to crushing in lb. per sq. in., within 28 days after mixing
	Fine	Coarse	
I Ordinary	1¼	2½	2,925
II Concrete	1⅞	3¾	2,550
III	2½	5	2,250
IV	7½		1,480
V	10		1,110
VI	12½		740
VII	15		370

"Quality A Concrete" mixes are set out below.

Designation of Concrete	Cub. ft. aggregate per 112 lb. of cement		Minimum crushing resistance in lb. per sq. in. within 28 days after mixing	
	Fine	Coarse	Prelim. test	Works test
IA	1¼	2½	5,625	3,750
IIA	1⅞	3¾	4,950	3,300
IIIA	2½	5	4,270	2,830

Testing

Generally the district surveyor can demand tests on any mix of concrete used in building work. For "Ordinary Concrete" works tests are only made if the D.S. requires them, but in the case of "Quality A Concrete" works tests shall be made when and how the D.S. so requires, and also preliminary laboratory tests may be required before the actual work is commenced.

Frosty Weather

During mixing, placing and setting the temperature of the concrete shall not fall below 40°F.

BYELAW 15

Steel

This shall comply with B.S. 15 : 1936. In particular cases reinforcement (for slabs only) of hard drawn steel wire shall conform to B.S. 785 : 1938 or High tensile steel conforming to B.S. 548 : 1934 or of any other quality or metal other than steel may be used in accordance with the L.C.C. conditions for each case.

BYELAW 34

Pressures on Concrete. Plain Concrete Filling

Designation of Concrete	Maximum permissible pressure in tons per sq. ft.
IV	20
V	15
VI	10
VII	5

BYELAW 35

Plain Concrete Foundations

The pressure on foundation concrete supporting walls or piers shall be calculated. Plain concrete shall be restrained against horizontal movement at its upper and lower extremities to the satisfaction of the D.S. and when so restrained may sustain the intensities of pressure given below for slenderness ratios up to 2.

Where such plain concrete is restrained satisfactorily top and bottom against horizontal movement but is not restrained to the satisfaction of the D.S. against such movement between the upper and lower extremities the pressure shall not exceed the maximum set against each ratio of height to least horizontal dimension shown below. Any other ratio and its pressure not shown may be found by proportion.

Ratio of height to least horizontal dimension (Slenderness Ratio)	Maximum permissible pressure in tons per sq. ft. for the respective designations of concrete				
	I	II	III	IV	V
Up to 2	40	35	30	20	15
3	36	31·5	27	18	13·5
4	32	28	24	16	12
5	28	24·5	21	14	10·5
6	24	21	18	12	9
7	20	17·5	15	10	7·5
8	16	14	12	8	6
9	12	10·5	9	6	4·5
10	8	7	6	4	3
11	4	3·5	3	2	1·5
12 and more	0	0	0	0	0

BYELAW 60

Plain Concrete Walls and Piers

(Slenderness ratio not exceeding 6)

Designation of Concrete	Cu. ft. of aggregate per 112 lb. cement		Maximum pressure in tons per sq. ft.
	Fine	Coarse	
I	1¼	2½	40
II	1⅞	3¾	35
III	2½	5	30
IV	7½		20
V	10		15
VI	12½		10
VII	15		5

Where the slenderness ratio is 12 the total stress shall not exceed 40 per cent of that given above. Where the slenderness ratios lie between 6 and 12 the permissible pressure may be calculated proportionately. No load bearing wall shall have a slenderness ratio exceeding 12 except cavity walls and partitions as constructed under byelaws 45 or 53 respectively.

End of L.C.C. Digest.

COPPER

The value of this metal is largely due to its high resistance to corrosion, giving an almost unlimited life. It may be used in the following forms :—

(1) Sheet and strip : for roofing, flashings and parapet gutters, eaves gutters and down pipes, bay-window tops, dormer tops and cheeks, damp-proof courses, cills and drips, tanks, cylinders and calorifiers, lightning conductors, facing to plywood, etc.

(2) Tubing : domestic water services, hot and cold ; panel, radiator and convection heating ; soil, waste and ventilating pipes, electrical conduit, tubular furniture and the conveyance of liquids or steam generally.

(3) Alloys : in which a wide range of colours is possible, such as bronze (copper-tin) and brass (copper-zinc), etc., for :—

Extruded and drawn sections for shop-fitting and architectural detail generally ; non-ferrous window and door frames ; wall-ties, masonry cramps and dowels ; screws and nails, and innumerable uses in architectural metal work.

Copper-work can easily be mastered by any worker skilled in the use of tools, but as with other materials, the metal has its own peculiarities and technique, and the advice of specialists should be sought before extensive designs and specifications are put in hand. The Copper Development Association is prepared to give free any advice required. A list of current C.D.A. publications on the uses of copper is given at the end of this section.

ROOFING

(See B.S. 899 : 1940 for cold rolled copper sheet and strip.)

Copper sheet roofing is of two kinds, traditional and the newer light-gauge systems.

Traditional copper roofing is generally carried out in hot-rolled sheet of dead-soft temper to allow for work-hardening. The weight of the material is measured in ounces per sq. ft. and 14 or 16 oz. (24 S.W.G.) is a usual and suitable weight ; 19 oz. (23 S.W.G.) need seldom be exceeded even for the highest class of work.

The copper is laid on an undercoating of felt or paper over close-boarding ¾″, ⅞″ or 1″, which should, if possible, be laid in the direction of the fall rather than across it ; the undercoating being intended to act as an insulation between the copper and any action that may occur due to the nature of the materials used in the roof structure.

FALL

Copper should not be laid on pitches flatter than 1½″ in 10 ft. but the steepness of pitch is immaterial and copper may even be applied to vertical surfaces without fear of " creep."

Drips are generally unnecessary in copper roofing work, but are formed where necessary in gutters by plain welts and underflashings.

JOINTING OF SHEETS

The sheets, of which almost any sizes are obtainable (14 sq. ft. being the " basis price " area in 24 S.W.G. but 8′ 0″ × 3′ 0″ being often found a more convenient and equally economic size in view of the reduction in joints) are generally formed in traditional work by either the " standing seam " method, being a double-lock welt left standing " proud " of the general surface of the sheet, or the " wood roll " of various shapes, the most popular being of conical section with rounded top, requiring 5″ of the copper sheet for its formation and being finished with a welt slightly to one side of the apex. Other rolls have a capping slid over the edges of the sheets, which are turned upwards and outwards at the sides and top of the roll, the edges being turned down and welted when the capping has been slid into position.

Both systems have been evolved to give not only an adequate water-lock but also to provide expansion joints to take up the inevitable movement of copper under temperature changes, which is, however, less than that of lead or zinc. For this reason the wood-roll is considered more suitable for flat roofs than the standing-seam, as it avoids the possibility of the expansion joints being trodden down flat.

In both methods the sheets are attached to the roof by copper strips or " cleats " nailed with copper nails, in a way which allows free movement.

Iron nails must never be used, and in fact the use of copper in conjunction with iron is generally avoided, in order to ensure that electrolytic action resulting in corrosion does not take place.

For this reason the nail-heads in the boarding must be well punched down and all loose nails removed before the felt or paper is fixed with copper nails.

Solder is to be avoided so far as possible on account of the risk of electrolytic or chemical action due to the use of an unsuitable flux. Resin or a resin paste only should be used as a flux.

CROSS JOINTS

These are generally made by double lock-welts without the use of solder, hammered down flat or even into prepared grooves in the boarding.

The cross joints should be arranged " staggered " to avoid the meeting of unwieldy thicknesses of metal at the junction with the " standing seam " or " wood-roll."

INCIDENTAL ROOFING DETAILS

Flashings of various types, aprons, string-stepped flashings, chimney-backs, parapet gutters, etc., are carried out in hot-rolled sheet, both for copper and for slate or tile roofs. Eaves gutters and similar unsupported work should be of cold-rolled copper. " Strip " copper is a convenient form, being obtainable in widths of 2″ or less up to 24″ or more in width ; and up to 50′ or more in length.

Copper gutters should be supported and strutted at about 2′ to 3′ centres to withstand damage from ladders, etc., and should be jointed in lengths of 6′ to 10′ to provide for expansion. Corrugating or folding-up into mouldings increases their strength.

Downpipes in copper may be folded up from sheet to round, square or other section, or may be made of lengths of light-gauge solid-drawn tubing.

No painting is required for copper rainwater goods. Joints may be effected in gutters and down pipes by plain overlaps of 3″ laid in the direction of the fall, the metal-to-metal contact being sufficient without the use of jointing material.

WELDING FOR COPPER ROOFING

Oxy-acetylene welding may be applied to copper roofing work and other sheet details.

If this method is adopted, precautions must be taken to ensure that the traditional jointing methods are substituted by equally efficient expansion joints formed by welding.

Means must also be found to protect any inflammable understructure or surroundings by the use of asbestos sheeting or otherwise, if the work is to be done *in situ*. Only de-oxidised copper must be used for welding.

LIGHT GAUGE ROOFING

Methods of using copper in reduced thicknesses of from ·004″ (3 oz. per sq. ft.) or even less, upwards, in conjunction with hot or cold bitumen or other adhesives, are now available in this country, as is light-gauge copper backed with impregnated fabric. The bitumen or fabric undercoat provides resilience to withstand pressure without puncturing the copper, and a certain measure of insulation.

Similar systems have been in successful use on the Continent and in America for many years, and are suitable for both flat and pitched roofs.

They should not, however, be advocated for flat roofs where much traffic is to be expected, but may be regarded as an effective additional sheathing to concrete or asphalt.

Various jointing methods are employed, ranging from plain lapped joints stuck down with adhesives, the strips being laid horizontally on a "built-up" principle giving two or more thicknesses at each lap, to the welted "standing-seams" with cleats, running vertically up the pitch of the roof as used for the heavier-gauge work.

PROTECTIVE COATINGS ON COPPER

Copper needs no protection from corrosion other than the natural "patina" which the metal acquires on exposure to the elements.

This protective "skin," begun by the oxidation of the bright metal, is completed by the familiar green or grey-green patina, which is generally found in the case of roofs to be chiefly a basic sulphate of copper, but varies in chemical composition in accordance with the impurities in the atmosphere.

The green colour is sometimes masked with soot, etc., and assumes a buff or black colour ; it remains, however, equally protective.

This natural patina may take a considerable number of years to perfect itself, but various means of accelerating its formation artificially are in existence, though they cannot yet be said to have passed the experimental stage, since time and exposure alone can prove their lasting qualities.

DAMP-PROOF COURSES

Copper "strip" is suitable for damp-courses, being obtainable in all usual wall widths and in rolls of 50′ or more in length.

24 S.W.G. is suggested as a safe thickness, though lighter weights are feasible down to as 30 S.W.G. (·0124″).

The material adapts itself readily to inequalities in the bed without fracturing, will not squeeze out and is highly resistant to fire and corrosion. Tests have shown its resistance to shear to be adequate.

Joints may be made where necessary by a plain 3″ overlap. Drips and cills in copper are also easily formed from strip, but suitable precautions in their design must be taken to prevent green "run-off," sometimes present in the early stages of their weathering, before the oxidised "skin" is formed.

WATER SERVICES

Copper, since it is very resistant to corrosion, is particularly suitable for water services, pipes, cylinders, etc. Chemical research on the reaction on metals of drinking waters in Great Britain shows that copper is less dissolved by water than either lead or iron, and that water which is not acid in reaction may be used with copper in complete safety. Acid waters must be treated for acidity before being used with this metal. Water which is not fit to drink after passing through copper pipes could not be used with iron pipes without risk of excessive pipe corrosion : acid water of this sort would also be dangerous in lead pipes, although no visible warning would be given. Copper when in contact with an acid water will, however, reveal a green stain which is a valuable warning that treatment to correct the acidity is necessary. The smooth bore of copper piping reduces the tendency to furring and permits the use of smaller pipes for an equivalent delivery, while the high elasticity of copper reduces the risk of bursting during frost.

JOINTING OF TUBES

(See B.S.S. 659 : 1944, Light gauge copper tubes, and 864 : 1945, Capillary and compression fittings for use with light gauge copper tubes.)

The use of heavy gauge—and consequently dearer—copper tubes with screwed joints, as in steel or iron practice, has largely been superseded by the use of lighter gauges jointed by the following methods :—

1. *Compression Joints*

There are many satisfactory types of compression joints available for copper piping and fittings, intended for use with light-gauge piping. Suitable fittings, usually of gunmetal, are made and stocked by all makers, and cover practically every conceivable requirement met with in normal practice. Where such fittings may be considered objectionable owing to their bulky appearance, and for best quality work, screwed joints are used with copper piping of heavier gauge than that used with patent joints. For such work the copper pipe should be specified to be of "screwing strength," or the thickness given in S.W.G. Alternatively, the pipe should be specified to comply in thickness and threads with B.S.S. No. 61.

2. *Welded Joints*

In building estates, and in hotels, blocks of flats, and other large buildings where repetition pipe assemblies may be employed, the joints may be welded. This work is best confined to a suitable workshop or factory laid out for such products, as the skilled labour necessary is not usually available on the site ; and as the finished assembly of pipes and fittings is usually polished, plated or otherwise treated with a high finish, satisfactory arrangements can seldom be made on the job. Copper used for welding must be deoxidised and the welding should be carried out by skilled workmen, of whom the supply is rapidly being increased by special courses of instruction.

3. *Soldered or Sweated Joints*

The fittings, elbows, tees, bends, etc., are in the form of sleeves into which the ends of the tubes must fit accurately. The joints are wiped with flux, pre-heated with the blow-lamp on assembly and touched with solder, which is drawn up into and all round the joint by capillary attraction.

In some types of fittings the solder is incorporated so that the application of a blow lamp flame after assembly is all that is needed.

LIST OF C.D.A. PUBLICATIONS

Issued by the Copper Development Association, Kendals Hall, Radlett, Herts.

No. 3. "Copper Through the Ages" (Historical and general).
No. 4 "Copper Steels to Resist Corrosion" (Engineering data).
No. 5. "Sheet Copper Work for Building" (Practical handbook for architects, builders and plumbers).

No. 6. " Brasses " (Engineering and metallurgical data).
No. 7. " Behaviour of Copper on Exposure to the Elements " (Reprinted from the " R.I.B.A. Journal ").
No. 8. " The Use of Copper for Domestic Water Services " (Technical, for architects and water authorities).
No. 10. " Steel-cored Copper Conductors (Technical data for electrical engineers).
No. 11. " Cadmium Copper Conductors " (Technical data for electrical engineers).
No. 12. " Copper Data " (Engineering and metallurgical data).
No. 14. " Copper Alloy Extruded and Drawn Sections for Architects " (Semi-technical, for architects).
No. 15. " Bearing Bronzes " (Engineering and metallurgical data).
No. 16. " Brass and other Copper Alloy Wire and Wire Products " (Engineering and metallurgical data).
No. 21. " Copper as a Mould Material " (Reprinted from " Metal Industry ").
No. 22. " Copper for Bus-Bars " (Technical data for electrical engineers).
No. 23. " Copper in Chemical Plant " (Copper as a material of construction).
No. 24. " High Tensile Strength Brasses " (Reprinted from " Metal Industry ").
No. 25. " Copper Pipe-Line Services in Building " (Practical handbook for architects, builders and plumbers).
No. 26. " Brass Pressings " (Engineering and metallurgical data).
No. 27. " German Copper and Brass Welding Practice " (Technical data).
No. 28. " Copper and Its Alloys in Automobile Design " (Reprinted from the " Proceedings of the Institution of Automobile Engineers ").
No. 29. " Copper in Cast Steel and Iron " (Technical data for foundrymen, metallurgists and engineers).
No. 30. " Copper for Earthing " (Technical data for electrical engineers).
No. 31. " Aluminium Bronze " (Technical data for metallurgists and engineers).
No. 32. " Copper Alloys in Engineering—Their Adaptation to Modern Requirements " (Technical data for metallurgists and engineers).
No. 33. " Lead Bronze Bearings " (Technical data).
No. 34. " The Machining of Copper and Its Alloys " (Technical data for engineers).
No. 35. " The Resistance of Copper to Soil Corrosion " (Reprinted from the " Engineer ").
No. 36. " Classification of Copper and Copper Alloys " (Reprinted from " Metallurgia ").
No. 37. " Overhead Lines Loading Tables " (Technical data for electrical engineers).
No. 38. " Copper Alloy Resistance Materials " (Technical data for electrical engineers).
No. 39. " Copper and Copper Alloy Springs " (Technical data for engineers).

These publications are supplied free of charge to those giving evidence of responsible status or genuine interest.

CORRUGATED STEEL

Corrugated steel sheets are obtainable in lengths from 4′ to 12′, though the usual maximum length is 10′, and in thicknesses from 17 to 28 B.W.G.

Sheets are normally supplied galvanised, but " black iron " sheets (ungalvanised) are supplied to order.

The corrugations range from 3″ to 5″ (in heavy sheets) and the sheets are made a definite number of corrugations in width. (See table below.) For good work 16 to 18 B.W.G. is used ; for ordinary work 20 to 24 B.W.G., and for very temporary work up to 28 B.W.G. may be used.

B.S. 798 : 1938 for galvanised corrugated steel sheets adopts 24 B.W.G. as the standard thickness, with corrugations of 3″ pitch. The width of corrugation is 2 11/16″ minimum, and the depth 5/8″ maximum. This standard is now under revision.

The vertical or side lap is usually one corrugation, and end lap 6″. Sheets are fixed together at side laps by special rivets 6″ to 9″ apart and at every second corrugation for the end laps, all rivets being on top of the corrugations to avoid leakage. In addition to these sheet to sheet fixings they must be securely fixed to the roof purlins by special hook bolts in case of steel purlins or by special screws or washers in the case of timber purlins.

PROTECTED CORRUGATED SHEETS

Special types of corrugated sheets can be obtained with protective coats of bitumen, asbestos or other proprietary coverings for use under particular conditions where ordinary galvanised sheets would not be practicable.

APPROXIMATE NUMBER OF GALVANISED CORRUGATED SHEETS PER TON

Thickness	Corrugation	5′	5½′	6′	6½′	7′	7½′
16 B.G. "	5/5″ 8/3″	70	64	58	54	50	47
" "	6/5″ 10/3″	59	54	49	45	42	39
18 B.G. "	5/5″ 8/3″	86	78	72	66	62	57
"	6/4″	76	70	64	59	54	51
" "	6/5″ 10/3″	74	67	62	56	53	50
20 B.G. "	8/3″ 6/4″	114	104	95	88	81	76
"	7/4″	97	89	81	75	70	65
"	10/3″	95	86	79	73	68	64
22 B.G.	8/3″	139	127	116	107	99	98
"	10/3″	116	105	97	90	83	78
24 B.G.	8/3″	168	153	140	130	120	112
"	9/3″	154	140	128	119	110	103
"	10/3″	140	128	117	108	100	94
26 B.G.	8/3″	223	203	186	172	159	149
"	9/3″	204	186	170	157	146	136
"	10/3″	186	169	155	143	133	124
28 B.G.	8/3″	240	219	200	185	172	161
"	9/3″	220	200	183	169	158	147
"	10/3″	200	182	167	154	143	133

8′	8½′	9′	9½′	10′	11′	12′	Corrugation	Thickness
44	...	...	...	...	...	...	5/5″ 8/3″	16 B.G. "
37	...	...	...	...	...	...	6/5″ 10/3″	" "
54	51	48	45	43	...	...	5/5″ 8/3″ 6/4″	18 B.G. " "
48	45	42	40	38	...	...	7/4″	"
16	43	41	39	37	...	...	6/5″ 10/3″	" "
71	67	63	60	57	...	...	8/3″ 6/4″	20 B.G. "
61	57	54	51	49	...	...	7/4″	"
59	56	53	50	47	...	...	10/3″	"
87	82	77	73	69	63	...	8/3″	22 B.G.
73	68	65	61	58	...	...	10/3″	"
105	98	93	88	84	76	70	8/3″	24 B.G.
96	90	85	81	77	...	...	9/3″	"
88	83	78	74	70	...	...	10/3″	"
139	131	124	117	111	...	...	8/3″	26 B.G.
127	120	113	107	101	...	...	9/3″	"
116	109	103	98	93	...	...	10/3″	"
150	...	...	...	...	...	...	8/3″	28 B.G.
137	...	...	...	...	...	...	9/3″	"
125	...	...	...	...	...	...	10/3″	"

CUBING AND ESTIMATING

The Ministry of Health usually bases comparative costs for housing upon cost per sq. ft. of floor area. The cost per foot. cube is the best standard of comparison for general building work.

R.I.B.A. STANDARD METHODS OF COMPUTATION FOR CUBING

Length and Width Measurements—to be taken between the outer faces of the walls.

Height Measurements—to be taken from the top of the concrete foundations to (in the case of a pitched roof) a line midway between the point of intersection of the outer surface of the wall and roof, and the apex ; or (in the case of a flat roof) to a height of 2′ above the roof. In the case of a Mansard roof, its cubical contents to be calculated separately.

Projection—after measuring the main structure an additional cube is to be measured for the following projections :—

(*a*) Bays and Oriels.
(*b*) Porches.
(*c*) Turrets and Flèches.
(*d*) Dormers.
(*e*) Chimney stacks.
(*f*) Lantern lights.
(*g*) Terraces and External steps.

CYCLES

DIMENSIONS OF CYCLES

	Length	Width	Height
Roadster Machines ...	6′ 2″	19″	3′ 6″
Sports Machines ...	5′ 6″	17″	3′ 0″
Juvenile Machines ...	5′ 3″	16″	2′ 9″

RACKS

Cycles in racks may be stored at 10″ centres with an allowance of 15″ for each of the two end cycles. These dimensions assume the racks to be constructed of light steel bars, and alternate cycles having their front wheels raised about 12″ from the ground.

The concrete slab type of rack is slotted diagonally to receive the cycle wheel. Slots are at 12″ centres and the slabs can be placed in a variety of positions to suit particular space requirements.

DAIRY FARMS

See :

Report of Ministry of Agriculture Committee on Farm Buildings (Post-War Building Studies, No. 17, H.M.S.O. 3s. 0d. net), "Farm Buildings" by Edwin Gunn (Crosby Lockwood, 10s. 6d. net) also "Modern Farm Buildings" by D. N. McHardy (Crosby Lockwood, 1932, 8s. 6d.)

DAMPCOURSES

See B.S.S. 743 : 1941, 1067 : 1942 and 1097 : 1943.

The usual damp courses consist of :—

(*a*) Two courses of slates laid to break joint in cement mortar.
(*b*) ¾″ Asphalt laid hot in two coats.
(*c*) Bitumen-impregnated sheet felt (sometimes with a thin sheet of lead interposed between the two layers of felt).
(*d*) Sheet lead, properly protected against corrosion.
(*e*) Perforated stoneware slabs, 2″ thick.
(*f*) Two courses of blue Staffordshire bricks laid in cement mortar.
(*g*) 24 to 30 S.W.G. Copper.

MODEL BYELAWS (SERIES IV) 1938

Byelaw 14. Damp-proof courses.

Requires the use of any of the following methods of providing a damp-proof course :

(*a*) Two or more courses of slate laid to break joint and bedded in cement mortar.
(*b*) A layer of sheet lead (4 lb.) bedded in lime mortar and joints lapped 3″.
(c) A layer of soft-tempered copper (1 lb. per sq. ft.) bedded in lime mortar or cement mortar and joints lapped at least 3″.
(*d*) Two or more courses of blue bricks or other engineering bricks bedded in cement mortar and incapable of absorbing more than 3 per cent of moisture after a 24-hours' immersion test.
(e) Asphalt or other bituminous material conforming to B.S. 743 : 1941.

DOORS

STANDARD DOORS

When using standard doors for interior joinery work it is advisable to plant a stop which can be adjusted on the lining, unless the exact thickness of the door is known. Door thicknesses recommended for domestic use are :—

Front Door	2″
Doors to Internal Rooms ...	1⅜″ to 1⅝″
Doors to Cupboards, etc. ...	⅞″ to 1⅛″

B.S. 459 Part I : 1944 specifies detailed dimensions for panelled and glazed wood doors. The following are the standard overall dimensions :

	Height	Widths
Internal doors	6′ 6″	2′ 0″ 2′ 3″ 2′ 6″ 2′ 9″
External doors ...	6′ 6″	2′ 6″ 2′ 9″
Casement doors ...	6′ 6″	2′ 9″ 3′ 10″
Garage doors	6′ 6″	7′ 0″

B.S. 459, Part II : 1945 provides for flush plywood doors for internal and external use in the same overall sizes.

B.S. 644, Part I : 1944 standardises outward opening type casement doors in the following sizes :

Type	Size
C.D.1 Single leaf ... ... C.D.4 do	6′ 8¼″ × 2′ 11½″ 7′ 8⅞″ × 2′ 11½″
C.D.2 Double leaf ... C.D.3 do	6′ 8¼″ × 4′ 1″ 6′ 8¼″ × 4′ 10″
C.D.5 Double leaf ... C.D.6 do	7′ 8⅞″ × 4′ 1″ 7′ 8⅞″ × 4′ 10″

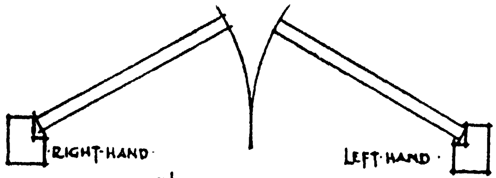
FRAMES

The Ministry of Health "Housing Manual," Appendix C, recommends the following for wood doors :

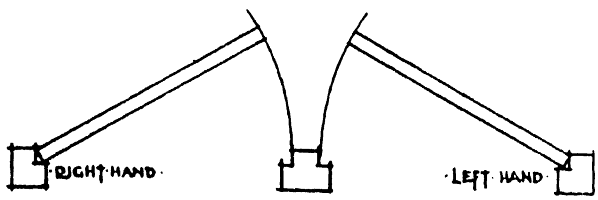
External : Solid rebated ex 4″ × 2½″ bedded in mortar, and fitted with fixing holdfasts. Hardwood threshold ex 4″ × 2″.

Internal : Linings ex 1¼″ stuff with planted stop.

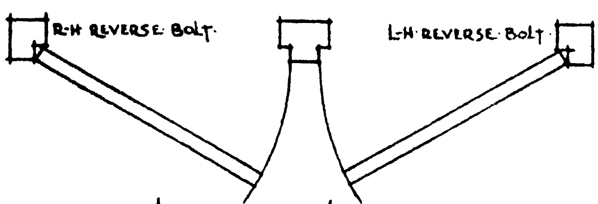
The diagrams given below show the usual trade conventions and may be useful when specifying door furniture.



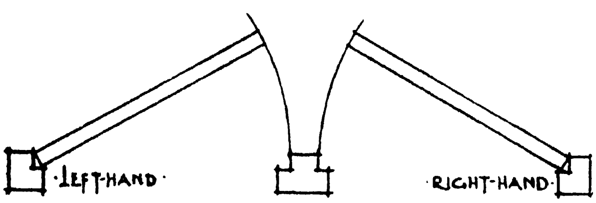
FLOOR-SPRINGS



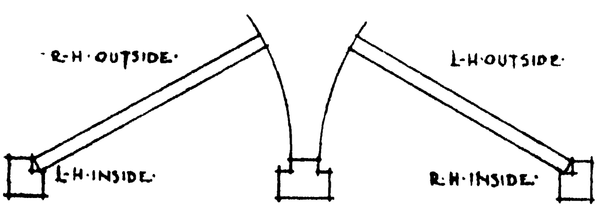
LOCKS AND LATCHES
DOOR OPENING INWARDS



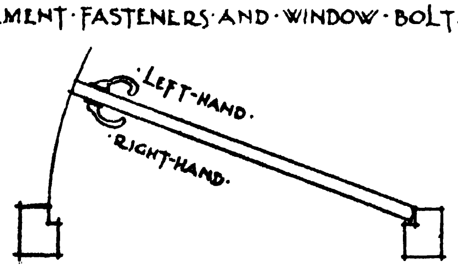
LOCKS AND LATCHES
DOOR OPENING OUTWARDS



RISING BUTTS AND LIFT-OFF HINGES



CASEMENT FASTENERS AND WINDOW BOLTS



DOOR HANDLES LEVER HANDLES AND LOCK-PLATES

SLIDING DOORS (TO GARAGES, ETC.)

Various types of sliding doors are available and full particulars are set out in the makers' catalogues. Where these doors are intended to slide round a curved overhead track, the leaves of the door should not be made of greater width than 2′.

REVOLVING DOORS

These should be made not less than 6′ in diameter.

FLUSH DOORS

These are of two main types ; one has a laminated core similar to that in the thicker plywoods, the laminations being at right angles to the finished door surface ; the other and more usual type has a built-up or framed core to which the plywood sheets are cemented.

There are many patented methods of finishing the edges of the plywood. Flush doors can be constructed solid to meet the L.C.C. and other requirements as to fire-resisting doors.

In selecting flush doors of the built-up type upon a hollow core, care should be taken to see that there is sufficient wood in the styles to allow for mortice locks being securely fixed at whatever height is desired.

See B.S. 459, Part II.

DOOR LOCKS

If doors have narrow styles they should be fitted with sash locks and should have lever handles on the reveal side to avoid contact between the door linings and the knuckles of the hand.

With lever handles of heavy material or long leverage the lock spring must be strengthened, unless the handle itself contains a balancing spring.

DOOR HANDLES AND HINGES

B.S. 459, Part I standardises the position of the centre of the lock mortice at 3′ 3″ from the top of the door. Hinges are planted at 9″ and 5′ 9″ from top of door to top of hinge.

DRAINAGE

(For Septic Tanks, etc., see under "Sewage Disposal." For Water Closets, etc., see under "Water Closets, Earth Closets and Privies.")

Outside London the drainage of buildings is governed by byelaws made by the appropriate local authority, these byelaws (unlike those in London), being based invariably upon the Model Byelaws issued from the Ministry of Health.

DIGEST OF L.C.C. DRAINAGE BYELAWS, 1934

Note.—This digest was prepared with the collaboration of Mr. E. Thomas Swinson, F.R.San.I.

INTERPRETATION OF TERMS

(1) The byelaws include among the interpretation of terms, the following :—

"Slop Sink" means a sink constructed or adapted to be used for receiving solid or liquid excremental matter.

"Soil fitment" means a water-closet, slop sink, or a urinal.

"Waste-water fitment" means a bath, lavatory basin, bidet, or a sink other than a slop sink.

(2) PARA. 1. SUBSOIL DRAINS

A sub-soil drain must not connect directly (i.e., without the intervention of a suitable trap) with any sewage drain, sewer, or surface-water drain communicating with a sewage drain or sewer.

(2) PARAS. 2 AND 3

Where a subsoil drain discharges into such sewage drain, sewer or surface-water drain it must be ventilated by an opening placed as near as possible to the trap. The trap must have a 2″ seal and the drain between the trap and the sewage drain, sewer or surface-water drain must be constructed as laid down for sewage drains.

(3) SURFACE-WATER DRAIN

A surface-water drain must be constructed as laid down for sewage drains, but the diameter may be less than 4″. Where it is intercepted from a sewage drain or sewer by a suitable trap communicating directly with the open air and furnished with adequate means of access (if the inlet to the surface-water drain is not less than 10′ distant from any building), the inlet may be in the form of an untrapped gully having proper provision for catching sand or other detritus and covered with a grating with bars not more than ⅜″ apart. If this drain receives only rain-water from roofs the inlet may be in the form of an untrapped gully as just described, or in the form of a rain-water shoe.

(4) RAIN-WATER PIPES

Rain-water pipes conveying rain-water to a sewer must discharge directly or by means of a channel into or over an inlet to a surface-water drain or sewage drain as described in (3). A rain-water pipe must not discharge into or connect with any (1) soil pipe, (2) soil ventilating pipe, or (3) any waste pipe or waste ventilating pipe connected directly with a sewage drain.

(5) PARAS. 1 AND 2. SEWAGE DRAINS

Sewage drains must be laid to a suitable fall and where practicable in a direct line. They must be at least 4″ in diameter and of first quality glazed stoneware, of cast iron effectually protected (inside and outside) against corrosion, or of other equally suitable material.

The thickness, weight, etc., must conform with the particulars given in the appended schedule on tables Nos. 1 and 2.

(5) PARAS. 6 AND 7

Sewage drains must be laid on a concrete bed 6″ thick and the pipes haunched up to half their external diameter, except where the drain is of cast iron and above ground, in which case adequate support must be provided at each joint.

(5) PARA. 9

Sewage drains within or under buildings are not permitted except where any other situation is impracticable. A stoneware sewage drain constructed within or under a building must be encased in concrete at least 6″ thick.

(5) PARA. 11. INLETS TO SEWAGE DRAINS WITHIN BUILDINGS

A sewage drain within a building must not have any inlets thereto, except such as may be necessary from any soil fitment, or any waste water fitment connected directly to the drain.

Provided always that a drain inlet other than those specified may be provided within a building if an external position is impracticable, but in this case the inlets must be trapped by a suitable trap (see below) fitted with a suitable cover and provided where considered necessary with adequate means of ventilation to the external air.

(5) PARA. 12. INLETS TO DRAINS TO BE TRAPPED

All inlets to a sewage drain other than a ventilating pipe must be properly trapped by a suitable and efficient trap capable of maintaining a water seal of :—

(*a*) 2″ where the inlet has an internal diameter of not less than 3″.

(*b*) 3″ where such inlet has an internal diameter of less than 3″.

(5) PARA. 14. TRAPPING OF DRAINS FROM SEWER

(*a*) If an intercepting trap is provided it must :—

- (i) Be formed and fixed so as to maintain a water seal of 2″.
- (ii) Be provided with a clearing arm fitted with a secure and suitable stopper as a means of access to the drain between the trap and the sewer.
- (iii) Be fixed as near as possible to the sewer connection.
- (iv) Be provided with a manhole or other means of access for purposes of clearing.

(*b*) If an intercepting trap is not provided, any portion of a sewage drain within or under a building must be in cast iron.

(5) PARA. 15. DRAINS TO BE WATER-TIGHT

A sewage drain must be water-tight and able to resist a pressure of 5′ head of water when tested *in situ*.

(5) PARA. 16. MEANS OF ACCESS

Means of access to a sewage drain must be provided and must be :—

(*a*) Adequate and water-tight.

(*b*) Fitted with a suitable cover at ground level, provided always that where the means of access is within or under a building or to a drain without an intercepting trap, it must have a suitable screwed or bolted air-tight cover, and where the means of access is a manhole such cover shall be fixed to the channel of the manhole and be in addition to the cover at ground level. In this last case the manhole need not be water-tight.

(5) PARA. 17. VENTILATION OF DRAINS

(*a*) Where an intercepting trap is provided, at least two ventilating pipes are required ; one as near as practicable to and on the inlet side of the trap, and the other as far as practicable from the trap.

(*b*) Where an intercepting trap is not provided, at least one ventilating pipe is required at a point as far distant as practicable from the connection of the drain with the sewer.

(*c*) Every such ventilating pipe must :—

- (i) Be carried up vertically to such a height and position as to prevent any nuisance or injury or danger to health arising from the emission of foul air from such pipe.
- (ii) Have an internal diameter of not less than 3″.
- (iii) Be furnished at the foot with an airtight access cap or cover.
- (iv) Be constructed in the same manner as laid down for a soil pipe.

(*d*) A soil pipe or ventilating pipe of any soil fitment, or waste pipe or ventilating pipe of any waste-water fitment where such a pipe is connected directly to a sewage drain may be used as a drain ventilating pipe if the position and diameter, etc., are in accordance with (*a*), (*b*), and (*c*) (i), (ii), (iii) and (iv).

(6) PARA. 1. SOIL PIPES AND VENTILATING PIPES

Every such pipe must be easily accessible throughout its course and adequately protected where necessary from damage, and conform to the L.C.C. requirements.

(6) PARA. 2

Such pipe must be at least 3″ in internal diameter. Where the outlet of the trap of any connected fitment is more than 3″ internal diameter, the internal diameter of the soil pipe must not be less than that of the outlet.

(6) PARA. 5

A soil pipe or soil ventilating pipe must not connect with any rain-water pipe, or with any waste pipe or waste ventilating pipe unless such waste pipe or waste ventilating pipe is constructed as stated in byelaw (10) para. 2 hereafter, i.e., on the "one-pipe system."

(6) PARA. 6

There must not be any trap between a soil pipe or soil ventilating pipe and the drain to which it is connected.

(6) PARA. 7

A soil pipe must be water-tight and capable of resisting a minimum pressure of 5′ head of water when tested *in situ*.

(8) PARA. 2. SLOP SINKS AND URINALS

Waste pipes and waste ventilating pipes to these fitments must be constructed as laid down for soil pipes, but the internal diameter of the waste pipe of any urinal may be not less than 2″ where the urinal has not more than two stalls and 1½″ in the case of a single urinal.

(8) PARA. 3. TRAPPING OF WASTE PIPES

Every waste pipe must be trapped immediately beneath a slop sink or urinal by a suitable tubular trap having an outlet with the internal diameter not exceeding that of the waste pipe to which it is connected and provided with means for inspection and clearing. Where two or more urinals are fixed in a range, the waste pipes may discharge without the interposition of a trap into an open channel in or on the floor immediately beneath or in front of the urinal, provided that the channel discharges into a suitable and efficient trap.

(9) PARA. 1. VENTILATION OF TRAPS

If a soil pipe or waste pipe of any soil fitment is connected with any other such fitment, or if the soil pipe or waste pipe is connected with the waste pipe of any water-waste fitment, (i.e., on the "one-pipe" system) the trap of every such soil or waste-water fitment must be ventilated as follows :—

A trap ventilating pipe must :—

(*a*) (i) Be connected with the trap or branch soil pipe or waste pipe at a point not less than 3″ nor more than 12″ from the highest part of the trap.

(ii) Be connected in the direction of the flow and on that side of the water seal nearest to the soil or waste pipe.

(*b*) Be carried into the open air to a point as high as the top of the soil ventilating pipe or waste ventilating pipe or turned into either of these pipes at a point above the highest fitment connected to such pipe.

(c) Where the vertical distance between the invert of the outlet of the lowest trap connected with the soil pipe or waste pipe and the invert of any horizontal pipe or drain into which the soil or waste pipe discharges is less than 10′, the trap ventilating pipe must be continued downwards and connected with (1) the soil pipe, waste pipe or drain at a point not less than 9″ and not more than 2′ below the invert of the lowest branch soil pipe or waste pipe connection, and have adequate means of inspection at the connection; or (2) a manhole in the line of such drain.

(9) PARA. 2

Branch and main trap ventilating pipes respectively must have an internal diameter not less than :—

(*a*) 2″ where connected with a soil pipe or waste pipe 3″ or more in internal diameter.

(*b*) Two-thirds of the respective internal diameters of the branch and main waste pipes where they are less than 3″ in internal diameter, with a minimum diameter of 1¼″.

(9) PARA. 3

Where the internal diameter of the trap ventilating pipe is less than 1½″ the pipe must be of non-ferrous material.

(10) WASTE-WATER FITMENTS

A waste pipe from a waste-water fitment, a waste ventilating pipe, a trap ventilating pipe and any trap connected therewith must have an internal diameter not less than 1¼″ and be constructed of the materials and in the manner hereinafter prescribed in paragraphs 1 or 2 of this byelaw.

(*Note*.—The following requirements (para. 1) relate to waste pipes discharging over or into a trapped gully.)

(10) PARA. 1. CONSTRUCTION AND TRAPPING OF WASTE PIPES

If such waste pipe discharges over or into a trapped gully, such waste pipe and any ventilating pipe or trap connected therewith must conform with the following requirements :—

Such waste pipe, vent pipe and trap must be :—

(*a*) (i) Constructed of non-ferrous metal where the internal diameter is less than 1½″.

(ii) In conformity with L.C.C. Standard requirements, if of lead, copper, cast, wrought iron, or stoneware.

(*b*) Every such waste pipe must be trapped immediately beneath the waste-water fitment by a suitable and efficient tubular trap capable of maintaining a water seal of at least 1½″ and having an outlet with an internal diameter not exceeding the internal diameter of the waste pipe to which it is connected and be provided with means for clearing and inspection. Provided always :—

(i) That where two or more baths or lavatory basins are fixed in a range the waste pipes may discharge without a trap into an open channel in, on, or above the floor immediately beneath such baths or lavatory basins discharging into a suitable trap.

(ii) That the waste pipe of any sink fixed in an outbuilding not approached directly from an occupied building need not be trapped if it does not exceed 3′ 6″ in length and discharges over a suitable trapped gully as provided for sewage drains.

(10) PARA. 1 (*d*). VENTILATION OF WASTE PIPES

Where any such waste pipe is connected with two or more fitments fixed on different storeys of a building it must be continued upwards without diminution of its diameter to such a height and position as to prevent any nuisance or injury or danger to health, and have the open end fitted with a suitable grating or cover.

(10) PARA 1 (e). VENTILATION OF TRAPS

To preserve the seal of any trap of a waste-water fitment the trap must be ventilated whenever necessary by a ventilating pipe carried to such a position as not to be a nuisance, etc. Where such pipe is connected to the traps of two or more fitments fixed on different storeys of the building, it

must be carried up as high as the top of the waste ventilating pipe or turned into it at a point above the highest fitment. Every such trap ventilating pipe must be connected with the trap or branch waste pipe at a point not less than 3″ nor more than 12″ from the highest part of the trap, in the direction of the flow, and on that side of the water seal nearest the waste pipe. The branch and main trap ventilating pipes respectively must have an internal diameter of not less that two-thirds the respective internal diameters of the branch and main waste pipes, provided that where the internal diameter of the waste pipe exceeds 3″ the internal diameter of the ventilating pipe need not be greater than 2″.

(10) PARA. 1 (*f*). WASTE PIPES TO DISCHARGE INTO THE OPEN AIR OR INTO A TRAPPED GULLY

Every such waste pipe must be taken through the external wall of building and discharge in the open air over a properly trapped gully or into such gully above the level of the water therein.

Provided always that where it is impracticable to discharge such a pipe in the open air it may discharge within the building in the manner set out for sewage drains (5) paras. 11 and 12, and above the level of the water in the trap.

No waste pipe must connect with or discharge into a hopper head, rainwater gutter, or rainwater pipe, unless such rainwater pipe is constructed in the manner prescribed for a waste pipe and unless the inlets to the rainwater pipe are so situated as not to be a nuisance.

(10) PARA. 2. ONE PIPE SYSTEM

If such waste pipe or ventilating pipe is connected directly with any sewage drain, or sewage drain ventilating pipe, or the soil or waste pipe or ventilating pipe of any soil fitment, such waste pipe, ventilating pipe and any trap connected therewith must conform with the following requirements :—

(*a*) Such waste pipe and ventilating pipe must be constructed of the materials and in the manner set out in Byelaws 6 and 7 for soil pipes and soil ventilating pipes. Provided always that the internal diameter of such waste pipe or ventilating pipe may be less than 3″ but not less than 1½″.

(*b*) Trapping of waste pipes.—Every such waste pipe must be trapped immediately below such fitment by a suitable and efficient tubular trap capable of maintaining a water seal of :—

(i) 2″ where the inlet has an internal diameter of not less than 3″.

(ii) 3″ where the inlet has an internal diameter of less than 3″.

The trap must have an outlet with an internal diameter not exceeding the internal diameter of the waste pipe to which it is connected and be provided with adequate means for inspecting and clearing.

Provided always that where the internal diameter of such pipe or trap is less than 1½″ it must be of non-ferrous material.

PLANS

These must be in duplicate on cloth or linen and deposited at least seven days before the work is commenced, or if in connection with a new building, at least seven days before the commencement of the erection.

SCALE

The scale must not be less than 1″ to 16′, except in case of block plans, which must not be less than 1″ to 88′.

Plans, sections and elevations must show :—

1. The position of every fitment and trap.
2. The fall of every drain.
3. The position and size of every drain, manhole, trap, gully, soil pipe, waste pipe, vent pipe and rain water pipe.
4. The height and position of every chimney belonging to and position of every window or outer opening into the building concerned within 20′ from the open end of a soil pipe or ventilating pipe.
5. The levels of the lowest floor of the building and of the street adjoining.
6. The levels of all yards, areas, ground or open space in connection with the building.
7. The scale to which the plans are drawn.

BLOCK PLANS

These must show :—

1. The position of the buildings on the premises and so much of the adjoining properties as may be affected.
2. The names of streets immediately adjoining, and the designation of premises.
3. The lines, size, depth and inclination of proposed drains and those of the existing drains, with the arrangements for the ventilation of the drains. The points of the compass.

SCHEDULE OF PIPES

Tables are given by the London County Council specification for pipes as referred to in the Drainage Byelaws. In general, pipes in accordance with the appropriate British Standards are acceptable.

End of L.C.C. digest.

PUBLIC HEALTH ACT, 1936

The following are notes on certain sections of the Public Health Act, 1936, dealing with drainage outside London. The special London Acts contain substantially similar requirements. It should be particularly noted that (outside London) the person affected by a local authority's requirements in these matters has, by the Public Health Act, 1936, a right of appeal to the ordinary magistrates. (See special article "Appeals," p. 193.)

PROVISION OF SINKS AND DRAINS

Section 37 empowers the local authority to require, in every new building, the provision of a proper sink and drain thereto, or other necessary appliance for carrying off refuse water from the building. Section 39 of the same Act deals with drainage of existing buildings.

DRAINS, NOTICES OF PROPOSED ALTERATIONS

Section 41 requires that where Section 39 of the Public Health Act, 1925 was in force immediately before the commencement of the Act, at least 24 hours notice in writing be given to the local authority before any drain is altered or reconstructed, and free access to the works must be given to any officers of the local authority.

The effect of this is broadly that certain rural districts remain exempt from these requirements as to notice.

SEWERAGE PLANS

Under Section 32, the local authority must prepare a map of the sewerage system of their district, and such map shall be kept at their office and be open for the inspection by all persons at all reasonable times.

PUBLIC SEWERS ON PRIVATE LAND

Under section 15, the local authority may carry a sewer along any street, or after reasonable notice in writing to the owner or occupiers, under or through any private land. The Act provides for the payment of compensation. Disputes may in general be settled by arbitration as provided for in the Act. Where the sum in dispute is under £50, the matter may be referred to a Court of Summary Jurisdiction.

BUILDING OVER SEWERS

Under Section 25, no building may be erected over any sewer shown on the map above mentioned without prior written consent from the local authority.

NEW BUILDINGS MUST BE CONNECTED TO SEWER

Under Section 37 penalties are imposed for failure to provide and connect approved drains from any new building where there is a sewer within 100′. Where there is no sewer within 100′, then drains shall discharge into a cesspool or some other place.

DRAINAGE OF BUILDINGS IN COMBINATION

By this is generally understood the system whereby the drains from two or more houses, not within the same curtilage are joined before they enter the sewer proper. This system was at one time commonly employed in certain districts and showed on occasion considerable saving in cost, particularly in cases where the sewer connections were costly to make and where long rows of property were being erected together.

Under the Public Health Act, 1875, a common drain (i.e., a drain connected to two or more houses) might without the concurrence of the local authority, vest in them, and be repairable at their expense as a sewer. As a result, many authorities were anxious to limit their liability for such repairs and in the past prevented the system wherever possible. It should be noted that where a row of houses is maintained by one owner, repairs may not be troublesome, but should the property be sold to a number of persons serious difficulties may arise.

Under Section 38 of the Public Health Act, 1936, where a local authority considers that two or more buildings might be more economically or advantageously drained in combination they may sanction the construction of a private sewer to this end. The local authority has the power to fix the proportions of the cost and maintenance of this sewer and where the sewer exceeds 100′ the excess of this distance may be borne by the local authority. But a sewer constructed by the local authority under this section shall not be deemed a public sewer by reason of the fact that the expenses of its construction are in the first instance defrayed by the authority or that part of these expenses are borne by them.

The section is in force in all Urban districts, Boroughs and County Boroughs, but only in those Rural districts where, on application by the Rural District Council it has been put into force by order of the Minister of Health.

SEWER CONNECTIONS

Under Section 34 the owner or occupier of any premises within the district, after giving notice to the local authority, may connect his drains to the sewers of the local authority. The local authority may, if they think fit, carry out the work of making the connection themselves. They have a (strictly limited) right of refusing to allow the connection subject to appeal to a court of Summary Jurisdiction.

CONNECTION TO SEWERS OUTSIDE THE DISTRICT

Under Section 35, connection may be made to a sewer in a district other than that in which the premises to be connected are situated, upon terms to be agreed. Any dispute as to terms may be settled by a Court of Summary Jurisdiction or by Arbitration.

MATTER WHICH MAY NOT BE PASSED INTO A SEWER

The Act, and the Public Health (Drainage of Trade Premises) Act, 1937, contain provisions on this subject too elaborate to set out here. A good summary of these provisions will be found on p. 115 *et seq.* of "Sanitary Administration" by S. Swift (Butterworth, 1944. 35s. 0d.).

GENERAL NOTES ON DRAINAGE

The following notes are intended to supplement the information on this subject usually found in local byelaws.

DRAINAGE BELOW SEWER LEVEL
SEWAGE LIFTS

Where lavatories, W.C.'s or other water consuming fittings are installed below the level from which they may be drained directly to main sewer connections, some form of storage chamber is essential from which the waste or sewage may be lifted by the sewage lift. In most cases it is advisable that such equipment be installed in duplicate, especially when sewage is to be dealt with or when failure of the equipment would mean putting portions of the building out of use, as would be the case in an hotel where the kitchens, wash-up, staff lavatories, etc., are situated below sewer level.

Any form of sewage lift used in such positions should be controlled automatically, usually by means of a float operating a switch, valve or other starting and stopping device and the duplicate equipment must be ready for service immediately a break-down occurs.

The storage chamber should have sufficient capacity to take at least 3 hours normal flow, unless the duplicate plant is arranged to come into operation automatically, i.e., without the necessity of waiting for an attendant to switch over.

Where the waste to be handled is relatively clear and free from solid matter, sewage, etc., the ordinary type of centrifugal or rotary pump is suitable for most cases ; but where solids or sewage are to be handled, the pump must be capable of breaking up or digesting such matter, or must be of an "unchokable" type. An alternative frequently used is an ejector plant operated by compressed air.

SIZES OF DRAINS

Taking a six-roomed house as a unit, a 4″ diameter drainpipe falling 1 in 50 will drain :—

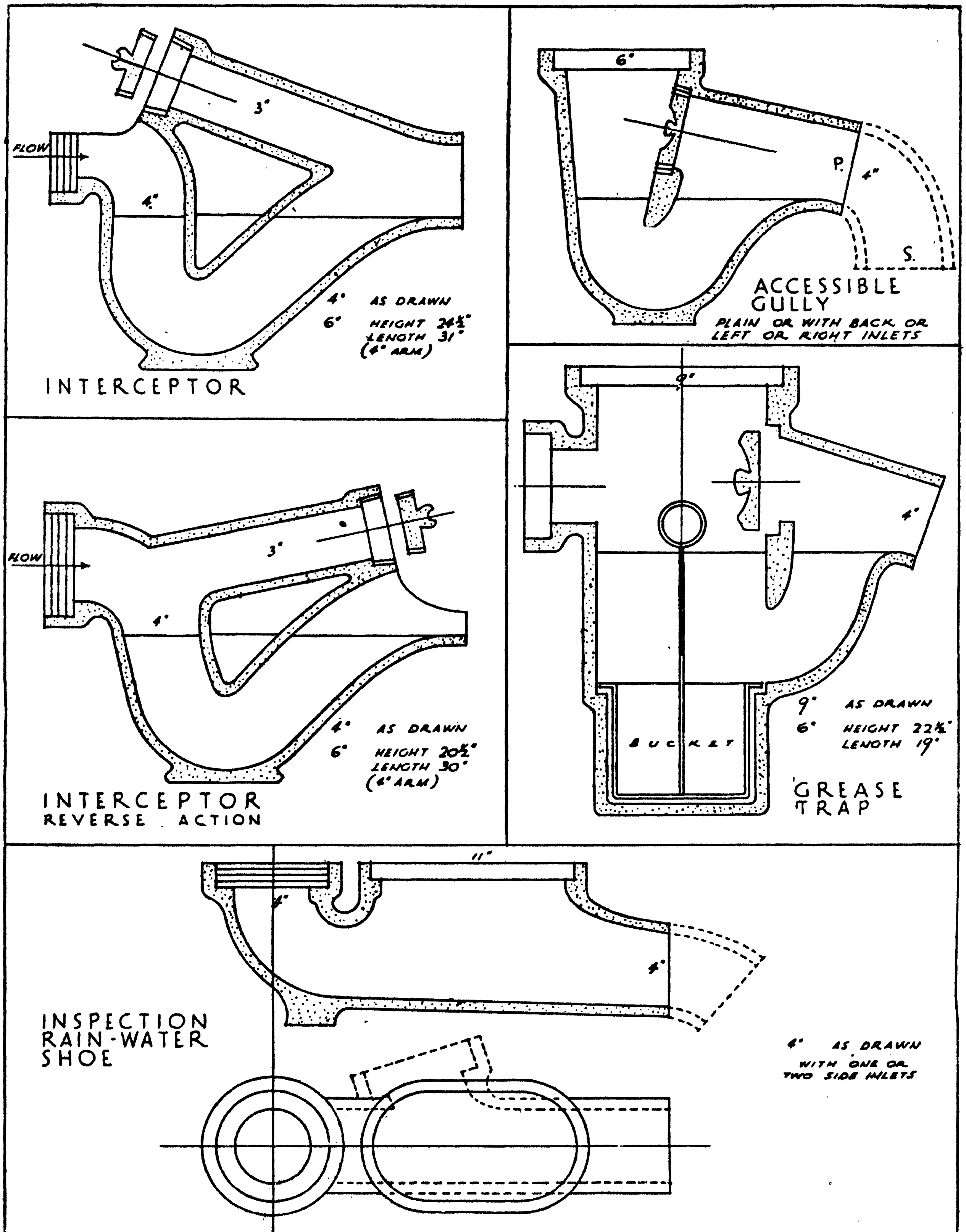
10 houses, foul water only.
8 houses, surface water only.
4 houses, combined system.

A 6″ diameter drainpipe falling 1 in 100 will drain :—

60 houses, foul water only.
18 houses, surface water only.
9 houses, combined system.

SIDE BRANCHES TO MANHOLES

These are composed of ¾ round or ½ round channels. The maximum number of entering side branches determine the inside length of the manhole. To obtain the approximate inside length of a manhole allow not less than 9″ for ½ round side branches, and not less than 12″ for ¾ round side branch with an additional 4″ end clearance on the side with the greater number of entering branches.



GLAZED STONEWARE DRAIN FITTINGS *TYPICAL EXAMPLES*

MANHOLES

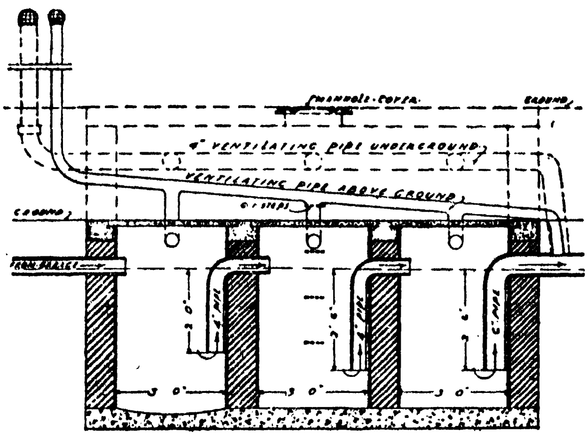
For convenience in rodding, manholes should not be further apart than 120′ in a straight length of drain, but less is better, due to the risk of breaking rods in long runs.

Suggested Minimum Internal Dimensions for Manholes

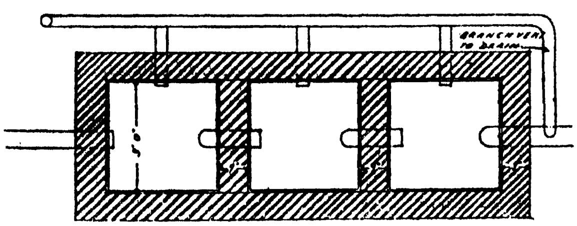
Description of Manhole		Length	Width
Shallow Manholes	(up to 2′ 6″ in depth)	1′ 6″	1′ 6″
Medium ,,	(2′ 6″ to 5′ 0″ ,,)	2′ 3″	1′ 10½″
Ordinary ,,	(over 5′ 0″ ,,)	Less than 3′ 4½″	2′ 7½″
Deep ,,	(over 5′ 0″ ,,)	More than 3′ 4½″	2′ 3″

PETROL INTERCEPTING CHAMBERS

It is forbidden under Section 27 of the Public Health Act, 1936, to permit any petroleum spirit or other oil giving off an inflammable vapour at a temperature of less than 73° F. to pass into a public sewer. For small private garages this may be prevented by the use of a special garage intercepting gully, but in the case of large garages an intercepting tank must be installed to act as a trap for petrol and oil.



Section of Intercepting Tank.



Plan of Intercepting Tank.

This may consist of a covered tank about 10′ 6″ long by 3′ 0″ wide and 3′ 0″ deep (from inlet level), and be divided into three equal and separate chambers. The drainage matter flows from the first to the last chamber through pipes, bent down in each case into the liquid so as to draw off some distance below the level of the liquid. In the first chamber the lower end of the draw-off pipe is about 12″ above the floor of the tank to avoid conveying sludge matter to the next tank. The lower ends of the draw-off pipes to the other two tanks may be 6″ above the floor level of the tank. Each chamber must have a branch vent pipe, joining the main vent pipe, to carry off any explosive gas which would otherwise accumulate, and also a branch connection to ventilate the drain as shown in the sketch. The tank given in the sketch above complies with the London County Council's requirements for petrol and oil interceptors.

Note.—The dotted portion shows an alternative arrangement where site conditions necessitate a deeper tank. In this case the division walls need be carried up only to a height of 5′, and the tank sealed above with one manhole cover only. The ventilating pipe may have the branches connected below ground and be fixed to the wall. The actual thickness, etc., of the cover to the tank will depend on traffic conditions.

See "Minimum Specification, No. 3." Published by Institute of Plumbers, 81, Gower Street, W.C.1. Price 2s. 2d., post free.

NOTE ON ONE-PIPE DRAINAGE

The term "one-pipe" drainage is a misnomer, as more than one pipe is used; but briefly the method consists of utilising one pipe for both soil and waste discharges from fittings and apparatus fixed inside a building, with a separate common vent pipe.

The system is practically universal in the U.S.A. and it is now universally (or almost universally) legal in this country, the byelaws which formerly forbade it having been brought into line with model byelaws of the Ministry of Health, which lay down the necessary safeguards.

See P.W.B.S. No. 4, "Plumbing" (H.M.S.O., 1944. 1s. 0d.) for discussion of the one-pipe system as applied to small houses, with description of tests carried out on various experimental systems, also p. 52.

LAND DRAINAGE

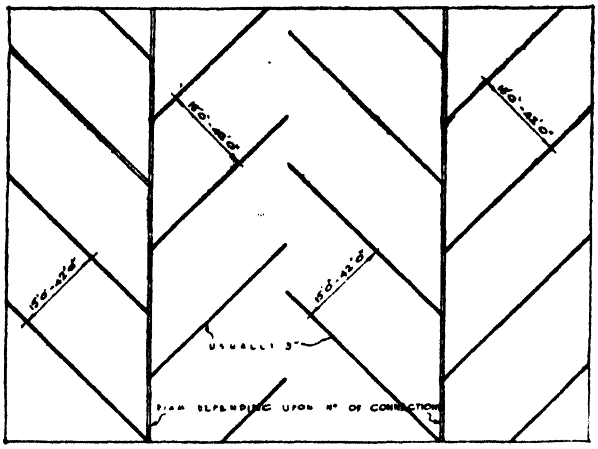
Architects are sometimes required to make surveys of land intended for building purposes, gardens and sports ground during dry weather, when it is difficult to determine the need for drainage.

The presence of Coltsfoot, Silverweed and Horsetails on arable land, and rushes, sedges and tussock grass on grass land, may be an indication of the need for drainage. In heavy land—particularly in grass land—it is possible to utilise the mole drain system. In this no pipes are used but instead a subsoiling plough is drawn along the lines of the minor drains to which is attached an extra deep tine having a shell, known as the mole, of from 2″ to 3½″ diameter. This forms a cylindrical tunnel which in heavy soil generally keeps open for from 10 to 15 years. The outflow from the mole drains is connected up in the ordinary way with pipes. Work can only be carried out with the aid of heavy tackle, and so is only suitable for areas of about 4 acres and over; but for such areas it is very economical in first cost.

Ordinary land drainage is now always carried out with cylindrical pipes, the old saddle-back tile being obsolete. Pipes are normally of unglazed clayware, but porous concrete pipes are available. They are laid with slightly open butt joints. B.S. 1196 : 1944 specifies unglazed clayware field drain pipes from 2½″ to 12″ diameter in lengths of 12″, and up to 24″ for the larger sizes.

The efficiency of the whole scheme depends upon obtaining an adequate fall and permanently unobstructed outlets, the number of which should be reduced to a minimum. The fall should not be less than 1 in 200. Main drains are laid about 4″ deeper than the outlets of minor drains at the point of junction, and two minor drains must not discharge

on opposite sides of the same point into a main drain, as this will cause silting up. The usual lay-out is in the form of a staggered herring-bone as shown below.



AGRICULTURAL DRAINS

Description of Soil	Distance of Drains Apart	Depth of Drains	Approx. No. of Pipes per Acre
	ft.	ft. in.	
HEAVY SOILS			
Clay (pasture)	15	2 6	2,904
Friable clay (pasture) ...	18	2 6	2,420
Free clay (pasture) ...	21	3 0	2,074
MEDIUM SOILS			
Stiff clay loam	21	3 0	2,074
Free clay loam	24	3 0	1,815
Gravelly clay loam ...	27	3 3	1,613
Friable clay loam	30	3 3	1,452
LIGHT SOILS			
Light gravelly loam ...	33	3 6	1,320
Light marly loam	36	3 9	1,210
Sandy loam...	39	5 0	1,117
Soft light loam	42	4 0	1,037

DRAWINGS FOR LOCAL AUTHORITIES

DEPOSIT OF PLANS, NO EFFECT AFTER CERTAIN INTERVAL

Under Section 66 of Public Health Act, 1936, the local authority may require by notice in writing, the deposit of fresh plans, when the work shown on the plans first deposited has not been carried out during a period of three years from the date of such first deposit.

RETENTION OF PLANS AND DOCUMENTS

Section 64 (5) of the Public Health Act, 1936, permits the local authority to retain one copy of drawings, plans or other documents deposited with them under any byelaw, if (but only if) their byelaws require deposit in duplicate. The London law on this point is most exacting.

DRAWING PAPER SIZES

	In.	Centimetres
Antiquarian	53 × 31	134 × 78
Double Elephant ...	42 × 28	106 × 71
Elephant	28 × 23	71 × 57
Imperial	30½ × 22½	77 × 57
Super Royal	27 × 19	68 × 48
Royal	24 × 19	61 × 48
Foolscap	17 × 13½	43 × 34

DRY AND WET ROT IN TIMBER

See also "Timber Preservation" (page 144) and "Timber Pests" (page 141).

See *Bulletin No.* 1 of the Forest Products Research Laboratory, "Dry Rot in Wood," (H.M.S.O., 4th edition, 1945, 1s. 0d.).

also "Timber Pests," Timber Development Association Ltd.

The terms "dry rot" and "wet rot" in timber are usually ill-defined and are applied to widely varying conditions by different people.

"Dry Rot" normally refers to the condition of timber attacked by the fungus *Merulius lacrymans* and is so called owing to the dry powdery nature of the wood in the later stages of decay. This fungus requires moisture in the early stage of growth, but when well established is capable of producing sufficient water to become independent of external supply.

"Wet Rot," no longer a term in current use, used to refer either to the conditions brought about by weathering agencies where no fungoid attack is visible—as is sometimes the case with external wood railings—or to attack by such fungi as *Coniophora cerebella* and *Paxillus panuoides*, both of which require abundant moisture throughout their growth, and are only found in very damp situations.

Timber attacked by *Merulius lacrymans* may be recognised by the cracks running at right angles to the grain which break up the wood into cubes, and by the presence of the silver grey skins and strings of fungal growth which usually show here and there patches of a yellow coloration.

Wood decayed by *Coniophora cerebella* is usually much darkened and tends to split along the grain, and the branching strands of the fungus are dark brown or black.

When *Merulius* is present great care must be taken to eliminate every trace of infection ; if *Coniophora* alone is present only structurally unsound timber need be removed and if access of damp is prevented further outbreaks should not occur.

CAUSE AND TREATMENT

Dry rot in buildings is caused by (*a*) using infected timber (*b*) lack of through ventilation, resulting in the timber becoming exposed to damp, (c) absence of efficient insulation against damp where timber is built into walls. When dry rot has been detected, all infected wood should be removed and burnt, cutting out for 12" to 18" beyond the last visible signs of attack ; the walls and any brickwork exposed should be burnt over with a blow lamp or treated with some antiseptic. Any sound timber remaining and all new timber used for replacements should be treated with a tar oil preservative or a solution of sodium fluoride of 4 per cent strength (6 ozs. to the gallon of water). Timber treated with this solution may be painted over after it has dried out. Through ventilation is essential wherever timber is used in a building. Solid floors adjoining wooden floors should have drain pipes laid under them for ventilation to the joisted floors. Where joists are laid on top of solid floors, ventilation should be provided. It is recommended that all timber in contact with solid floors, built into walls or exposed to damp air, should be treated with preservative. Where an attack of dry rot is suspected expert advice should be sought without delay. The F.P.R.L. Bulletin mentioned should be in the possession of every architect.

DUST BINS

These are made in galvanised iron corrugated or plain and either circular or square in shape.

Section 75 of the Public Health Act, 1936, empowers local authorities who do not themselves provide dust bins to impose requirements as to the types, etc., to be used. Their requirements are subject to appeal to a Court of Summary Jurisdiction. There may be special provisions in local byelaws.

B.S. 792 : 1938 covers four sizes of dustbins of nominal capacities from 1 to 3¼ cu. ft., smooth tapered sides and removable lid.

Capacity	Depth inches	Top diameter inches	Weight complete lbs.
1	14	14	13
2	20	16	20
2½	22	17	23
3¼	24	18	28

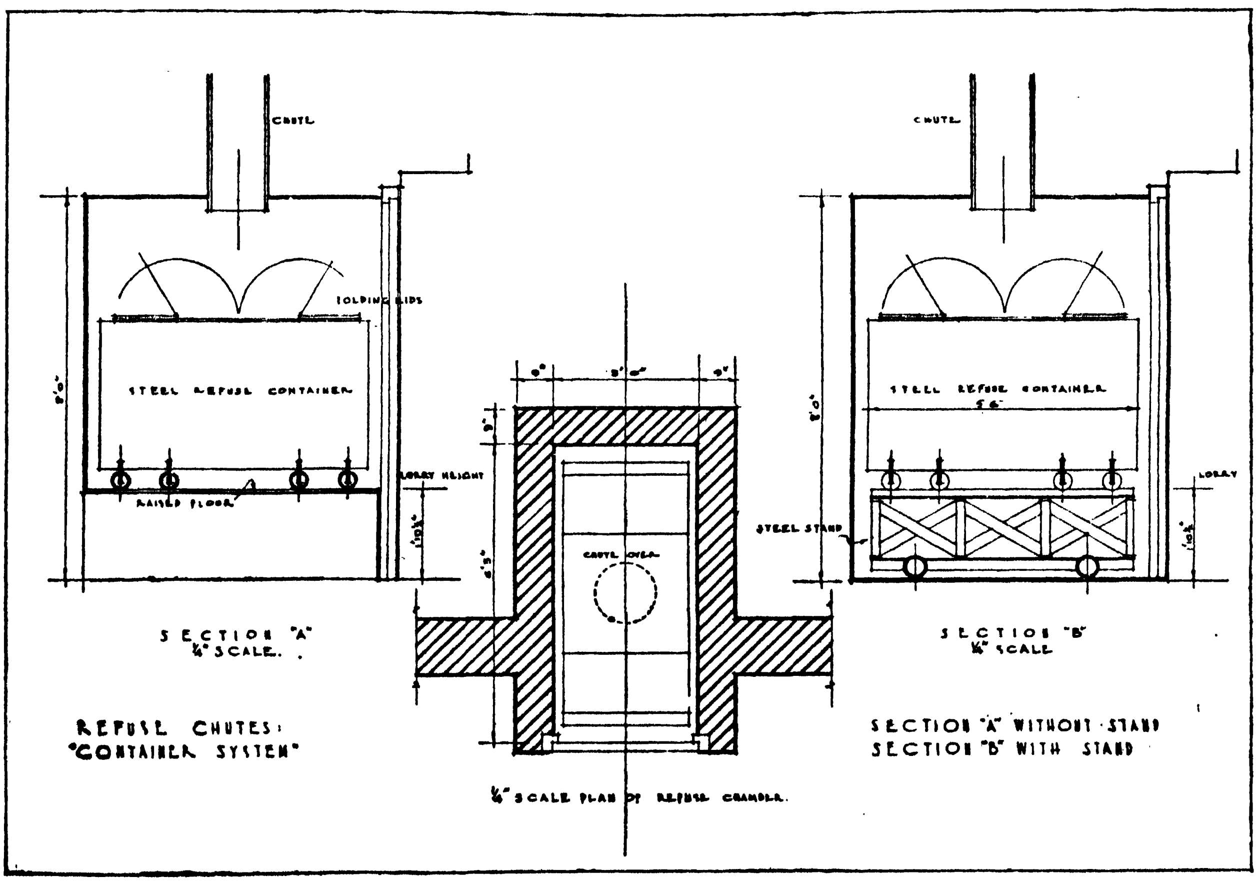
DUST CHUTES

Three typical systems, each designed to serve about 20 flats are illustrated below and on the following page.

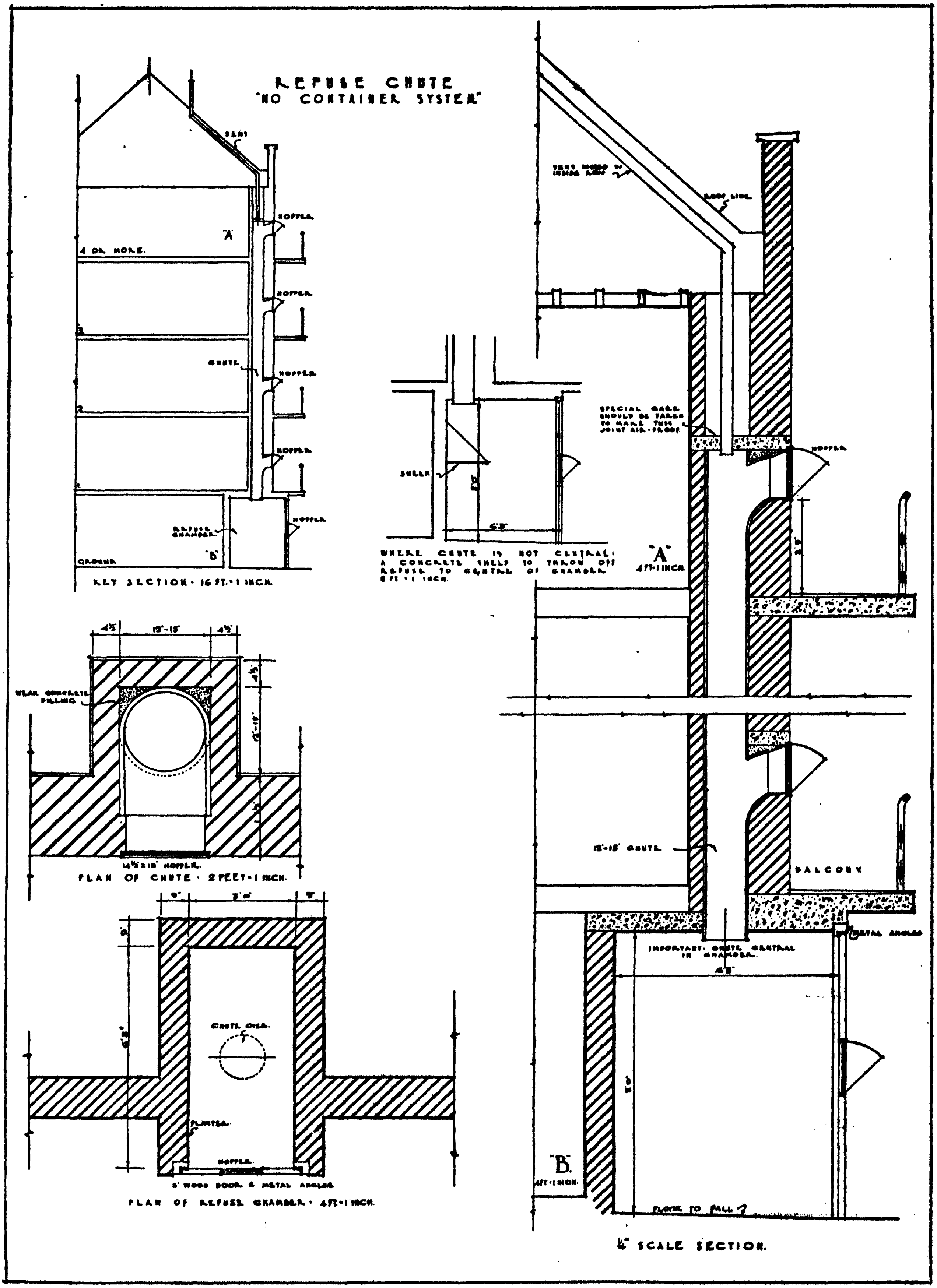
1. *No container system*
   Refuse discharges on to floor of chamber. Is shovelled into bin, wheeled to lorry for removal.
2. *Container system* (*a*)
   Refuse discharges into container on raised floor.
   (*a*) Container is sealed, put on stand and wheeled to lorry for removal.
   (*b*) Container is sealed and transferred direct to lorry for removal.
3. *Container System* (*b*)
   Refuse discharges into container resting on wheeled stand. Container is sealed and then wheeled to lorry for removal.

Ventilation is provided to roof level through a pipe leading out of the top of the chute.

Washing.—Provision should be made for washing the chamber from a convenient water point by means of a hose, with a gully for drainage.



Details of Dust Chutes



Details of Dust Chutes.

ELECTRICAL INSTALLATION

ELECTRICAL TERMS AND DEFINITIONS

Volt :	The unit of electromotive force or pressure.
Ampere :	The unit of current or intensity of flow.
Ohm :	The unit of resistance to the flow of current.
Watt :	The unit of power, representing a consumption at the rate of one ampere, with a pressure of one volt, i.e., Watts = volts × amperes.
Kilowatt :	1,000 watts.

Charges for electricity are based on the Board of Trade Unit or Kilowatt-hour, which represents a consumption of 1 kilowatt (or 1,000 watts) for a period of one hour. The Board of Trade Unit should not be confused with the B.Th.U. or British Thermal Unit, the heating value of the former being equivalent to approximately, 3,410 B.Th.U.

In a direct or continuous current system, the effects of the pressure, current and resistance, i.e., volts, amperes and ohms, obey what is known as Ohm's Law, usually expressed in the form :

$$C = \frac{E}{R}$$

$$\text{or } E = CR$$

$$\text{or } R = \frac{E}{C}$$

when C = current in amperes.
E = Electromotive force or pressure in volts
R = resistance in Ohms

SUPPLY SYSTEMS

The new Electricity Acts have regulated and co-ordinated supplies and will ultimately provide uniform systems of distribution and uniform voltages. For domestic supply the standard supply is 3-phase Alternating Current (A.C.) at a pressure of 230 volts between phases for lighting, heating and small power requirements. For general power requirements the standard fixed is 3-phase A.C. at a pressure of 400 volts. Obsolete systems of supply are :—2-Wire Direct Current (D.C.) ; 3-Wire D.C. ; Single, 2 and 3-phase A.C. with pressures varying from 100 to 250 volts for lighting, heating, etc., and from 100 to 480 volts for general power purposes.

INTAKE AND DISTRIBUTION, IN RELATION TO SUPPLY SYSTEM

The system of supply does not affect the actual circuit wiring in the building, but does alter the conditions in the Intake and Distribution Room and affect the runs which may be adopted in the building.

Where electric motors are used, the differences between direct and alternating current are considerable, both in respect of the cabling to the machines and their type and performance. With D.C. motors speed control is obtainable easily in most cases by varying the strength of the magnetic field.

With A.C. machines, which will run only at or near what is called the "synchronous" speed, variations in running speeds are obtainable only by altering the arrangement of the stator poles or by inserting a variable resistance in the rotor circuit.

When variable speeds are essential, as is the case with a high speed lift installation, printing machinery, etc., it is common practice to instal a combination of an A.C. motor, directly coupled to a D.C. generator, which in turn supplies direct current to the motor driving the lift gear or other equipment.

A disadvantage with A.C. motors is that they exercise a much lower starting torque than D.C. machines, the current taken at starting under load being up to three times full load running current. This means that protective gear must be of sufficient capacity to deal with the starting current, with a consequent increase in cost.

CONSUMER'S SUPPLY CIRCUIT

Summarising the recommendations of P.W.B.S., No. 11, three separate circuits are suggested, viz. :—

	Number and diam. of wires In.	Current rating
Lighting circuits	1/·044	5 amps
Socket-outlet ring circuit ...	7/·029	15 ,,
Cooker circuit	7/·036	29 ,,

The ring circuit is intended to be fitted with standard socket outlets and can furnish current to heating and other appliances, standard lamps, radio and for a water-heater or wash boiler up to 3·5 kw. rating.

A standard 3 kw. "all purpose" (230 volt) socket outlet and fused plug has been adopted for domestic use and will be subject to a British Standard in preparation. (B.S. 1363.)

WIRING REGULATIONS

The standard wiring regulations usually adopted in this country are embodied in "Regulations for the Electrical Equipment of Buildings" published by the Institution of Electrical Engineers (11th edition, revised, December, 1943, 1s. 0d.). See also B.S. 1043 : 1942 "Code of Practice for the Provision of Engineering and Utility Services in Buildings," and B.S.S. 1062 : 1943 and 1064 : 1942.

FOUR SYSTEMS OF WIRING

(1) *Conduit System*

This consists of cables run in metal conduit. There are four types in general use :—(*a*) Close jointed, known as Slip Conduit ; (*b*) Continuity, or Pin-Grip ; (*c*) Heavy Gauge, Screwed, welded or brazed joints ; (*d*) Solid drawn, i.e., seamless.

Type (*a*) is obsolete and should not be installed.

Type (*b*) is used for competitive work of domestic type, but is not recommended for first-class work.

Types (*c*) and (*d*) are recommended for first-class work. They provide electrical and mechanical continuity througnout, thus facilitating effective "earthing" of the complete system.

The advantages of the Conduit System are :—

1. It may be installed during erection and the cables may be left out until actually required.
2. In the case of failure of the cables at any time, they may be withdrawn and replaced without disturbance to the structure.
3. Conduits provide definite and adequate protection to the cables.
4. Standard fittings are available for most requirements.

Sizes

The sizes are given in terms of the outside diameters and should be specified of ample capacity to facilitate wiring or subsequent re-wiring.

External Conduit

For external work or damp positions the conduit should be galvanised or sherardised, and kept clear of walls, etc., by means of spacing saddles and clips.

(2) *Soft Metal-sheathed System (Lead Covered)*

In this system, twin or three-core cables are used, insulated with rubber and enclosed in a tightly fitting soft metal sheath. The cable should not be placed in contact with new plaster, and where fixed to oak it is desirable to shellac both the cable and the oak. The cable should be free from kinks, which are dangerous, and should be fixed with clips sufficiently close together to prevent sagging. Suitable fittings are available for most requirements, and " earthing " is advisable.

The advantage of this system is that it can be used in positions where surface wiring is necessary with the maximum degree of concealment ; but it should be used only where the risk of mechanical damage to the cables is slight.

(3) *Tough Rubber-covered (Cab-tyre Sheathed)*

In this system single, twin or three-core cables are used, insulated with rubber and enclosed in a tough rubber sheath, and available with a wide range of fittings. The system is not usually " earthed," but all the fittings should be of insulating material where possible.

The advantages of this system are similar to those of the soft metal-sheathed type, with the additional ones of possessing damp-resisting as well as chemical and acid-resisting qualities. It should not be used where there is risk of mechanical damage unless adequate protection is provided.

(4) *Wood Casing and Capping*

This system, which is now obsolete, entails the use of wood casing, grooved to take the cables and covered with a wood capping which is screwed or nailed to the casing. It is not recommended for present-day work.

SWITCHES

These should be liberally inserted, as the control of several points by one switch is uneconomical except where all points so controlled are required to be used simultaneously at all times.

It is desirable that plug socket type points should be installed in all rooms for the possible connection of small power or heating devices, such as vacuum cleaners, floor polishers, kettles, irons, hot-plates, toasters, standard lamps, etc.

Where conduit or the " earthed " system is used, all switches should be provided with " earthed " dollies, i.e., means of providing metallic connection between the metallic switch-cover and the metal casing of the system. Shock-proof switches should be installed in bathrooms, having covers and dollies of insulating material.

ACCESS PROVISION

Ample facilities should be provided for inspection and future access by the insertion of suitable draw-in or inspection boxes. For steel conduits, junction boxes should be of iron or steel ; those for the soft metal-sheath system should be of steel ; those for the C.T.S. system are usually of fibre, Bakelite or similar insulating material.

CONSUMER'S SUPPLY UNITS

Standard control units embodying cable sealing box, main supply (sealed) fuse, 3 circuit fuses, disconnecting link to neutral, double-pole main switch, meter (quarterly or prepayment), and spare way or bell transformer, are recommended and described in P.W.B.S. No. 11.

FUSE BOARDS

Distribution or Fuse Boards should be liberally employed to facilitate the location and isolation of faulty circuits. Ample space should be provided for the Supply Authority's intake gear and meters, and also for the main distribution gear. A British Standard for meter and fuse cupboards is in preparation.

CABLE SIZES

These may be obtained from the Wiring Regulations of the Institution of Electrical Engineers, but for any given load a proper allowance must be made for the drop in voltage which increases directly with the length of the run. A cable suitable for a given load over a run of 20 yds. will not be suitable for the same load over a run of 40 yds. The voltage drop for lighting circuits must not exceed 2 per cent plus a permanent allowance of 1 volt.

Polyvinyl and other plastic insulated cables have largely replaced rubber owing to war-time shortages and seem likely to persist on their merits.

AUTHORITIES CONTROLLING WIRING

Wiring in buildings is subject to the conditions set out by certain authorities. These are : (1) Board of Trade, (2) Home Office, (3) Power Supply Authority, (4) Insurance Companies.

LIGHTING LOAD ALLOWANCE

No general rule can be given for determining the probable load, but for average lighting conditions and using glass of not more than normal absorbing qualities, an allowance of 1 to 4 watts per sq. ft. of area is usually ample. For obtaining the capacities and number of ways for Fuse Boards, not more than 6 amperes or more than 10 points may be connected to any final sub-circuit. (See p. 12 et. seq.)

HEATING LOAD ALLOWANCE

For heating purposes a reasonable allowance is from 750 to 1,000 watts per 1,000 cu. ft. of space to be warmed. Heating or other power sockets to which heavy loads are likely to be connected are preferably combined with switches, and interlocked to prevent the plug top being inserted or withdrawn with the socket " alive." In some districts this is insisted upon.

FAULTS IN WORKMANSHIP

The following faults occur in bad electrical work :—

1. Bends are used instead of inspection bends or angle boxes.
2. The tubing is threaded on to the cables as the work is done, instead of the cables being drawn through by means of " fish wires " after the tubing is completed.
3. The sub-circuits are overloaded on the distribution board.
4. Interior type non-watertight fittings are used in out-houses, garages and cellars, and for outside work.
5. Lead-covered cables are run through new oak beams. Gallic acid corrodes lead, and protection should be provided.
6. Unslaked lime or new plaster on lead cables.
7. Use of inferior holders.
8. Loose ceiling rose blocks.
9. Conduits and lead-covered cables placed in contact with Keenes or Gypsum Plaster.

References :

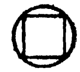
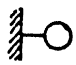
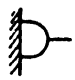
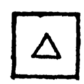
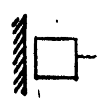
Institution of Electrical Engineers : " Regulations for the Electrical Equipment of Buildings." (Spon) 1s. 6d.

P.W.B.S. No. 11, " Electrical Installations." (H.M.S.O., 1944, 1s. 6d.)

British Standard Code of Practice, B.S. 1043. " The Provision of Engineering and Utility Services in Buildings." (B.S.I. 2s. 0d.).

List of British Standards, p. 171.

Graphical Symbols for use in connection with Interior Electrical Installations from British Standard Specification No. 447

CEILING POINT—LIGHTING		METER	
FLOOR POINT—LIGHTING		BELL PUSH	
FLOOR POINT—POWER		PEAR PUSH AND ROSETTE	
BRACKET POINT—LIGHTING		BELL	
LIGHTING WALL-SOCKET		BELL INDICATOR (N = No. OF WAYS)	
LIGHTING WALL-SOCKET AND SWITCH COMBINED		INDICATOR AND BELL	
POWER WALL-SOCKET		TELEPHONE POINT (PUBLIC SERVICE)	
POWER WALL-SOCKET AND SWITCH COMBINED		TELEPHONE BOARD (PUBLIC SERVICE)	
I-WAY SWITCH		TELEPHONE POINT (INTERNAL)	
2-WAY SWITCH		TELEPHONE BOARD (INTERNAL)	
INTERMEDIATE SWITCH		LOUD SPEAKER OUTLET	
MAIN SWITCH—LIGHTING		MASTER CLOCK	
MAIN SWITCH—POWER		SECONDARY CLOCK	

EXCAVATOR

In describing wheeling of excavated soil the term "run" is employed. One run is usually reckoned as 20 yds. A throw is usually reckoned as 6′, though in practice it is nearer 5′. In underpinning the minimum working room is usually measured as 2′ clear of the wall.

Width of the trench or working space is usually 2′, but for deep excavation this must be increased.

The Specification should state where soil, etc., is to be deposited, and whether top soil and turf are to be kept separate for garden or other purposes. The following table shows the average increase in bulk of material after digging; also the labour hours per cu. yd.

Nature of Material	Increase in bulk per cu. yd.	Labour hours, per cu. yd., dig wheel and tip
	per cent	
Vegetable soil or made ground ...	30	2·5
Firm earth	25	2·9
Clay	25	3·4
Gravel	10	3·6
Chalk	30	5·6
Hard Ground (using picks)	25	9·2

WEIGHTS AND NATURAL SLOPES OF EARTH

(See "Retaining Walls," p. 122.)

FACTORIES AND WORKSHOPS

Factories Act, 1937:

For most purposes, the old distinction between factories and workshops is swept away by this Act. Those affected are advised to refer to the Act.

Attention is drawn to the Home Office Industrial Museum 97, Horseferry Road, S.W.1., where examples of good and bad factory equipment and planning may be seen. Help and advice on such matters may be obtained from the officials at the Museum, and also from the Factory Inspectors for the District in which it is proposed to carry out the work.

FARM BUILDINGS

Consult Post-War Building Studies, No. 17 (H.M.S.O. 3s. 0d.). An illustrated report by a Committee appointed by Ministry of Agriculture and Fisheries containing a comprehensive treatment of modern requirements.

FELT

Roofing and other felts are classified as follows by B.S. 747 : 1937.

1. BITUMEN FELTS

1a. Impregnated Bitumen Felts

Impregnated bitumen felt consists of a close-textured felt made from a mixture of animal and vegetable fibres, which is impregnated with asphaltic bitumen but is not surface-coated.

This felt is used for the lower layers of multiple layer roofs and for laying under tiles or slates.

The weights vary from 10 to 50 lb. per 108 sq. ft.

1b. Sanded Bitumen Felts

Sanded bitumen felt consists of felt made from a mixture of fibres impregnated with asphaltic bitumen and surfaced while still heated with clean, washed sand.

This felt is used for a single layer roofing on temporary structures and on multiple layer roofs of non-permanent structures.

The weights vary from 35 to 65 lb. per 12-yd. roll.

1c. Self-Finished Felts

Self-finished felt consists of felt made from a mixture of fibres impregnated and coated with asphaltic bitumen and surfaced with talc or mica.

This felt is used for single and multiple roofing generally, as felting beneath slates or tiles, sealing cold storage chambers, etc.

The maximum weight of rolls 35 in. wide and 24 yds. long shall be as follows :—

Heavy	...	100 lb.
Medium	...	80 lb.
Light	...	60 lb.
Extra Light		40 lb.

1d. Mineralised Bitumen Felt

Mineralised bitumen felt consists of felt made from a mixture of fibres impregnated and coated with asphaltic bitumen and surfaced on the upper surface with slate granules, or similar mineral granules, and on the other side with talc or mica.

This felt is used for the external layer of multiple layer roofs or as a single layer roofing. It is also supplied cut to squares or octagonal slate sizes.

The weights vary from 40 to 90 lb. per roll of 12 yds.

1e. Reinforced Bitumen Felts

Reinforced bitumen felts consist of felt made of a mixture of fibres with a layer of hessian, impregnated and coated with asphaltic bitumen and surfaced with talc or mica.

This felt is used as a sheeting beneath slates or tiles on unboarded roofs.

The weight varies from 50 to 60 lb. for a 24-yd. roll.

2. IMPREGNATED FLAX AND HAIR FELTS

Impregnated flax and hair felts are made from open-textured felts in which long-fibred flax, jute or cowhair are used, entirely different from the close-textured, short-fibred felts used in "bitumen" roofing felts.

They must be either black or brown in colour, the former being impregnated with fluxed coal tar pitch, and the latter, the brown "Inodorous" felts, with brown wood tars or similar materials.

The absence of surface coating and the nature of the felt precludes their use either for the outer or the inner layers of multiple layer roofing. Their chief use is for sarking tiled or slated roofs, particularly the latter; their resilience is an important quality in this application because it yields a good bedding for the slates. They are also used for lining under mastic asphalt roofs.

The types and weights are as follows :

2a. Impregnated Flax Felt—Black

Felt made from flax, jute and/or similar vegetable fibres. Fluxed coal tar pitch.

Weight	Roofing	80 lb. per roll.
	Sarking	56 lb. „ „
	Black Sheeting	34 to 35 lb. per roll.

2b. Impregnated Flax Felt—Brown

("Inodorous Felt")

Base.—As 2a.

Impregnating Material.—Brown wood tars, wood pitches and similar material.

Weight	Special inodorous	60 lb. per roll.
	No. 1 Inodorous	50 lb. „ „
	No. 2 Inodorous	40 lb. „ „
	Brown Sheeting	34 to 35 lb. per roll.

2c. Impregnated Hair Felt—Black

("Black Hair Sheathing Felt")

Base.—Felt made from flax, jute, waste or cowhair or a mixture thereof.

Impregnating Material.—Fluxed coal tar pitch or similar material.
Weight.—80 lb. per roll.

2d. Impregnated Hair Felt—Brown
(" Bituminous Hair Felt, Brown ")
Base.—As 2c.
Impregnating Material.—As 2d.
Weight 80 lb. per roll.

3. TAR FELTS

These are used principally on temporary structures, such as garden sheds, poultry houses. Two main types, 3a and 3b, are manufactured.

3a. Impregnated Tar Felts
Are intended to be treated with tar and sand immediately after fixing on the roof.
Description.—Impregnated tar felt consists of a felt made of a mixture of fibres impregnated with fluxed coal tar pitch.

3b. Sanded Tar Felt
Description.—As 3a and surfaced with sand.

B.S. 989 : 1944 specifies bituminous roofing felts to War Emergency standards.

CARPET FELT

This is a soft hair felt, sometimes having a jute core for increased strength, and used under carpets to deaden sound, reduce the staining due to the passage of air through cracks in the flooring, and increase the " cushion " effect of the carpet.

CARPET FELT (PAPER)

This material is made from wood pulp or similar substance and is an economical substitute for hair felt : it does not give the same " soft " effect as the latter, but is more efficient in stain prevention.

FIRE ESCAPES

(See also " Staircases," p. 130.)

See London Building Acts Amendment Act, 1939, Sections 20 and 21 and 33 to 43 inclusive. Outside London, some provisions will be found in Sections 59, 60 of the Public Health Act, 1936, and many provincial towns also have special provisions in local Acts of Parliament.

MEANS OF ESCAPE

It may be generally stated that in the area controlled by the London County Council all new buildings, alterations to existing buildings, or converted buildings, will require plans to be submitted for approval of the Means of Escape.

OFFICE BUILDINGS. In computing the number of persons in office buildings for the purposes of means of escape it is the practice of the L.C.C. to allow 50 sq. ft. of floor area per person.

FACTORIES ACT, 1937

The provisions of Sections 34 and 35 of the Factories Act, 1937, apply both in London and in the provinces and (with certain exceptions) require that every factory shall be provided with such means of escape in case of fire for the persons employed therein, as can reasonably be required in the circumstances of each case. This is for decision in the first place by the L.C.C. or local authority, subject to a right of appeal to a Court of Summary Jurisdiction.
The means of escape required depend, *inter alia*, upon the following circumstances :—

(*a*) The area and disposition of the building.
(*b*) The number and the distribution of the persons for whom the means of escape are to be provided.
(*c*) The user of the building.
(*d*) The nature of the construction of the building.
(*e*) In the case of a building used for trade purposes the nature of the materials and goods stored or manufactured in the building.
(*f*) The provision of an efficient system of automatic fire alarms, sprinklers or other appliances.

It may, however, be laid down as a general principle that at least one enclosed and protected staircase and exit will be required, and in addition an alternative means of escape from each floor by one of the following means :—

(*a*) Another enclosed and protected staircase and exit in the same building.
(*b*) A suitable staircase in another block, to which access is given by door-way openings in the party or division walls or by external communication.
(*c*) External gangways or balconies affording access to adjoining or adjacent buildings.
(*d*) An external iron staircase.
(*e*) Any other suitable arrangement which will secure the desired object having regard to the circumstances of any particular case. No arrangement which is not permanently fixed in position or which requires manipulation in part or in whole in order that it may be used in case of emergency can be accepted.
(*f*) In all cases where considered necessary by the Council some means of escape from the roof of the building to the roof of the adjoining premises should be provided.

Where two or more means of escape from any floor are provided, they should be placed as far as reasonably practicable from each other so as to be approached from any part of the floor area independently of any one fire risk on that floor.

THEATRES, MUSIC HALLS, CONCERT HALLS, ETC. Premises to be used for music, dancing, stage plays, or entertainments of a like kind are specially dealt with by regulations made by the London County Council under section 12 of the Metropolis Management and Building Acts (Amendment) Act, 1878, and section 18 of the London County Council (General powers) Act, 1930.
See : " Regulations for places of Public Entertainment," No. 2606a and " Construction of Buildings in London," No. 3359. P. S. King and Son, 14, Great Smith Street, S.W.1.

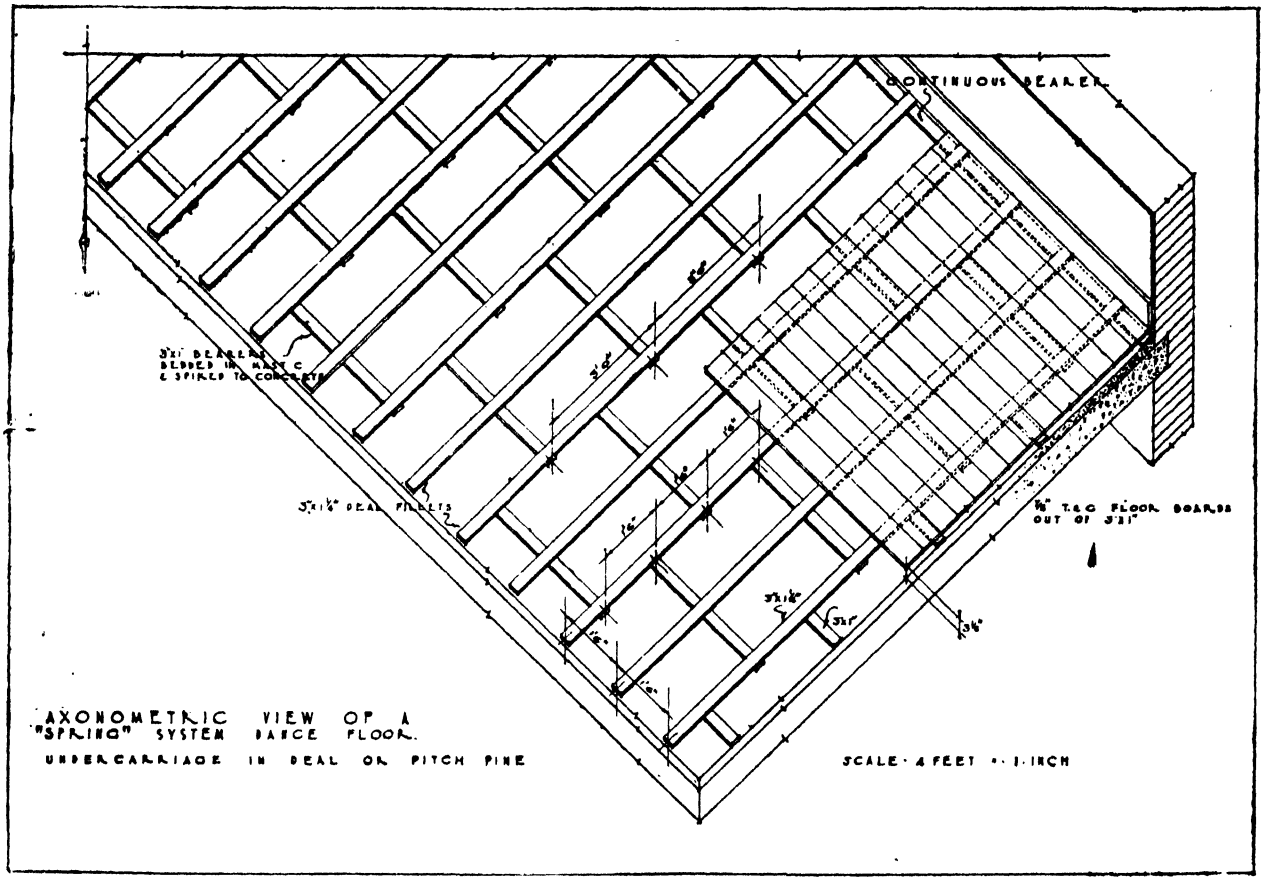
FIREPLACES AND HEARTHS

These are controlled by local byelaws both in London and outside. The provincial byelaws will be found to agree with the model byelaws issued from the Ministry of Health. The London byelaws differ in many details.
See B.R.S. recommendations for preventing smoky chimneys. " Notes from the Information Bureau of the B.R.S." 4th Series, No. 3.

FIRE RESISTING CONSTRUCTION AND MATERIALS

PROTECTION OF FABRICS, ETC., AGAINST FIRE

London Fire Brigade formula for the protection of fabric used on stand coverings, decorations, scenery sets, etc., for public exhibitions :
1 lb. Phosphate of Ammonia. 2 lb. Chloride of Ammonia. 1½ gallons of Water.



The above diagram shows a type of floor often used for dancing where a true spring floor would be too costly.

PREVENTION OF CORROSION OF METAL WORK DUE TO MAGNESIUM OXYCHLORIDE COMPOSITIONS

The essential fact to be borne in mind is that whenever magnesium chloride comes into contact with unprotected metal serious corrosion is very likely to occur. The corrosion, moreover, is liable to continue indefinitely, owing to the property of magnesium chloride of absorbing moisture from the air.

It is obvious, therefore, that direct contact between the oxychloride mix itself and any iron or steel must be avoided, but in addition it must be realised that the magnesium chloride solution used in joint-less floors, dadoes, skirtings, etc., is usually absorbed to some extent by the backing materials ; for this reason the zone in which corrosion is to be feared is not confined to the immediate proximity of the oxychloride composition itself.

Considering first the question of pipes or conduits passing through the oxychloride composition, it is necessary in every case to insulate the metal completely. This should not present any serious difficulty. The most obvious and probably the most satisfactory method is to pass the pipe or conduit through a sleeve left in the floor or wall before the oxychloride mix is placed. Alternatively, a small piece of bitumen felt might be wrapped round the pipe. Two or three coats of a good bituminous solution (not an emulsion) would probably afford sufficient protection, but there is the difficulty of ensuring that the pipe is completely protected all round, and also the bituminous film may be injured during the laying of the oxychloride mix. In view of the far-reaching damage which may ensue when a water-pipe is perforated, no pains should be spared to ensure that the insulation is thorough and complete.

The question of preventing the corrosion of metals embedded in the backing material is very much more difficult, and here the user is very much in the hands of the floor layer. Unfortunately, in many cases where oxychloride composition is to be laid, the backing provided consists of a porous cement mortar screeding which readily absorbs the chloride solution, and there is only a thin cover over the embedded metal. It seems reasonable, however, to specify that there should be at least an inch cover of dense cement mortar over all pipe conduits or structural steel. In addition, the likelihood of penetration of magnesium chloride solution to the metals by way of shrinkage cracks must be kept in view. A badly cracked or highly porous screeding is no fit base for a magnesium oxychloride finish. Furthermore, it should be stipulated that the floor layers should not be permitted to flood the base, prior to laying, with magnesium chloride solution. The necessary wetting should be carried out with slurry or wash of magnesite and water only, and the oxychloride mix itself should not be of a wet or sloppy consistency.

The question of location of the mixing plant is an important one. Continued mixing of floor material in one small area may result in adjacent material becoming saturated with magnesium chloride. It is preferable that mixing should be done in troughs or mechanical mixers rather than on the floor base, and it is sometimes insisted that the process be done outside the building altogether.

GRANOLITHIC PAVING

Granite chippings should be obtained from an approved quarry, and substitutes of lime-stone and sands should not be used. The aggregate should be specified to comply with the appropriate sections of B.S. 1201 : 1944.

A mix of three parts of ¼″ granite chippings and 10 per cent of coarse granite dust to one part portland cement is recommended.

An alternative specification is two parts of washed ¼″ Granite chippings and one half part of sharp sand to one part of cement ; for which it is claimed that the addition of sand prevents the paving from wearing slippery. It is essential that some finer material than ¼″ chippings be used to fill the interstices. If granite dust is used, care must be taken to see that it does not contain too much flour. If sand is used it must be thoroughly washed and sharp.

Granolithic paving should be laid in alternate bays, not exceeding 10′ × 12′, three-ply Willesden paper being inserted between the bays to allow for expansion. Usual thickness ¾″ to 1½″.

In large areas the alternate bays may be 30′ long but not more than 9′ wide, but it is held that the value of expansion joints is greatly diminished if they have not been constructed in the sub-floor also.

The concrete on which the granolithic is to be laid should be keyed, and the paving should be laid within 24 hours after the concrete has been placed.

When granolithic is laid on concrete already set, the floors should be thoroughly cleaned and all dust removed. The concrete should then have a wash of neat cement grout. Unless these operations are carefully carried out, there is considerable risk of the granolithic not having a perfect bond.

Traffic should not be allowed on the floors for at least seven days. This is important, and if it cannot be arranged the contractor should not accept responsibility for the paving.

The use of a rapid hardening cement for paving is not advocated owing to its high flour content, which tends to float to the surface when paving is being laid and will ultimately give a dusty floor.

A pre-mix hardener is sometimes preferred as being more efficient for rapid hardening and preventing dusting. The more usual method is a dressing of silicate of soda immediately after the final trowelling.

Ten tons of granite chippings will cover about 150 yds. super 2″ thick.

TERRAZZO FLOORS

Terrazzo is made of granulated marble mixed with either white, grey or coloured portland cement. It may be laid either in situ or supplied pre-cast in various forms. *In situ* Terrazzo is plastic when laid, and in this condition can be worked to curves of any shape, such as coved skirtings, wreathed strings, etc. After setting, the Terrazzo is rubbed down with carborundum blocks and polished.

When Terrazzo floors are laid *in situ* there is a risk that cracks may develop, and the following precautions should be observed :—

The aggregate should be carefully graded and an excess of cement avoided. The floor should be divided up with expansion strips into panels not exceeding 3′ × 3′. The strips, which should divide both Terrazzo and screed down to the concrete face, may be of ebonite, brass, zinc or other metal.

Where conditions are such that adequate curing is not possible with in situ work, it may be preferable to use pre-cast tiles or slabs.

The screed is an important factor in producing satisfactory results, and it is recommended that the screed and the Terrazzo be laid by the same contractor.

In America long experience of this material has resulted in the following method being used for good work :—

The Terrazzo floor should be separated from the structural floor. The procedure usually adopted is to lay a sand bed of ¼″ thickness, then building paper (waterproof) on the sand. The underbed or screed is laid on the paper to a thickness of 2″ and covered with the finished Terrazzo ⅝″ to ¾″ thick, thus giving a total thickness of 3″ from the top of the concrete to the finished floor level. The finished Terazzo coat is divided into slabs—of an area not exceeding 9 sq. ft.—by means of brass 20 B.W.G., lead ¼″ thick or vulcanite from ¼″ in thickness.

Pre-cast Terrazzo units embrace floor tiles, staircases, balustrades, partitions, columns, etc. Hydraulically pressed Terrazzo floor tiles can be obtained, the usual sizes being 9″ × 9″ × ⅞″, 12″ × 12″ × 1″ and 16″ × 16″ × 1¼″.

Pre-cast stair risers and strings should be ⅞″ thick and reinforced with wire-mesh : stair treads about 1½″ thick, reinforced with ¼″ rods or wire mesh. Pre-cast slabs should not be less than 1½″ thick.

MARBLE FLOORS

Marble paving slabs are usually ¾″ to 1″ in thickness and may be finely sanded, finely gritted, or polished (if not to be walked on). The slabs are solidly bedded in a mortar composed of one part of lime mortar to three parts of sand.

Stair treads which should not be polished may be 1¼″ to 2″ thick, solidly bedded in cement mortar 1 : 3. Risers may be ¾″ to 1″ thick, cramped to the step cores with brass wire cramps.

Note.—Where marble is to be laid on concrete in contact with the earth it is advisable to provide a layer of tar, pitch or other suitable water-proofing material under the bedding as a precaution against staining.

MARBLE MOSAIC

Marble mosaic cubes vary in size from ¼″ to 1″ square and up to ½″ thick. These cubes are generally stuck face downwards on paper, in small areas of one or two sq. ft. Each area is then bedded with the paper side up into a fresh cement screed, gauged 3 and 1 with a little hydrated lime to increase the fatness. When set the paper is washed off, cracks grouted up, and the whole ground levelled and polished.

RUBBER FLOORS

Where there is a concrete sub-floor, rubber flooring should be laid in large continuous sheets, as smaller sizes tend to come away from the concrete. It is essential that the concrete floor be perfectly dry before the rubber flooring is laid, and that the screed should be finished perfectly smooth. A rubber mastic cement is used for fixing the sheets either to wood or concrete surfaces.

LINOLEUM—CORK CARPET

B.S. 810 : 1938 specifies linoleum in thicknesses ranging from 1.90 to 6.70 millimetres : cork carpet in thicknesses of from 2.50 to 8.00 millimetres. Before fixing either type it is advisable to spread it out on the surface to be covered, and leave it for about a fortnight to allow the expansion to take place. Painted back linoleums should only be used on wood floors, and should be painted with a weak flour or casein paste. Plain backed linoleum is essential for fixing to concrete when a strong resinous or similar linoleum cement is used. The concrete or screed must be very smooth and dry.

Linoleum must not be laid on concrete which is itself in direct contact with the ground or hardcore beneath, unless there is a continuous asphalt, or similar adequate damp course.

CORK TILES

These are made by heating and compressing granulated cork and are available in several shades of brown and in different textures. The tiles vary in thickness and may be obtained in sizes up to 18″ by 18″. They are fixed in the same way as linoleum, and some varieties have tongued and grooved edges for additional security in fixing. The surface is then sanded off and polished ; a process which should be specified as it is not normally included in the estimate.

FLOOR SPACE AND SEATING ALLOWANCE

(See L.C.C. "Regulations for Places of Public Entertainment No. 2606a. 6d., from P. S. King and Son, 14, Great Smith Street, S.W.1.)

SEATING

The seating area assigned per person under the regulations of the L.C.C. for places of Public Entertainment is shown in the following table :—

	Width		Depth
Seat with arms	1′ 8″	Seat with back	2′ 4″
Seat without arms	1′ 6″	Seat without back	2′ 0″

In all cases the Regulations provide for a clear space of 1′ between the front of one seat and the back of the seat immediately in front. Except with the written consent of the Council no seat shall be more than 10′ from a gangway measured in the line of seating. Where unfixed chairs are used they must be screwed together in sets of not less than five.

FLOOR SPACE (per Person)

Restaurants, 12 to 16 sq. ft. (inclusive of table, gangways, etc.)

Ballrooms, 12 to 16 sq. ft. (per couple).

Office Buildings, 45 to 120 sq. ft. (usually taken at 60 sq. ft. per person).

School Classrooms, 16 sq. ft., upwards.

Public Schools, 20 sq. ft. and upwards per scholar.

HOTELS

The following figures are abstracted from "Hotel Planning and Outfitting" published by a firm of hotel fitters in the U.S.A. :—

Dining-Room	Seating Capacity	Area in sq. ft.	Area per seat
Hotel Coronado, St. Louis ...	184	2,142	11·5
Hotel Stevens, Chicago ...	600	9,522	15·87
Hotel Vanderbilt, New York	350	5,490	15·7
Average obtained from the complete table			13·4

The proportion of kitchen and offices area to the dining-room area gives an average of 3 : 7, i.e., the kitchen area is equal to 43 per cent of the area of the dining-room. This is for a restaurant with waiter service : for counter service lunch rooms this figure is approximately 30 per cent and for cafeteria service restaurants approximately 38 per cent.

FOOTINGS AND FOUNDATIONS

Both in London and outside, these matters are controlled by local byelaws. In the provinces, the byelaws will be found to agree with the model issued from the Ministry of Health. The London byelaws differ.

BEARING CAPACITIES FOR FOUNDATIONS

The L.C.C. Byelaws, 1938, require that the pressure upon the earth to support any part of a building shall be calculated if so required by the District Surveyor, who decides finally the allowable pressure.

SOILS

The following table, prepared by the L.C.C. only as a guide, gives the approximate bearing capacities of the more usual types of soil :—

	Tons per sq. ft.
Alluvial soil, made ground, very wet sand	½
Soft clay, or wet or loose sand	½–1
Ordinary dry clay, or confined sand, sandy clay, dry fine sand	2
Firm dry sand	3
Natural bed of compact gravel, London blue clay or chalk	4
Hard solid chalk	6

LOADS ON CONCRETE FOUNDATIONS (L.C.C. BYELAW, 1938)

Cement	Fine Aggregate cu. ft.	Coarse Aggregate cu. ft.	Safe load in tons per sq. ft.
1 cwt.	1¼	2½	40
1 cwt.	1⅞	3¾	35
1 cwt.	2½	5	30
1 cwt.	7½ (Mass Concrete)		20
1 cwt.	10 „ „		15

FUELS

(See also under "Boiler Houses," p. 28.)

The fuels easily available and in general use for heating boilers are coal, coke, fuel oils, gas and electricity. Before any kind of fuel is decided on, all the factors in the case should be carefully considered and the advantages and disadvantages of each class of fuel reviewed.

SOLID FUELS

Solid fuels, such as coal and coke, are usually the least expensive as regards the number of heat units available per unit of cost, but against this must be set the possible difficulty in providing suitable storage space and in arranging for reasonable delivery and the removal of waste. The risk of dust causing damage to the decorations or contents

of the building should also be considered. With solid fuels some provision must be allowed for regular—though not necessarily constant—attention to maintain the fires in good condition, and such labour allowance should be included in estimating the fuel costs.

An important development to solid fuel boilers ensuring ease of working, uniform temperatures and a saving in fuel is the recent application of automatic stoking and thermostatic temperature control. A refinement is the provision of a second conveyor, by means of which no hopper is needed, the fuel being delivered directly on to the furnace feed from the coal store. With this provision, relatively little attendance is required ; it is only necessary to make certain that the conveyor nozzle is covered and to see that the normal oiling and cleaning is attended to periodically.

It is essential to stipulate that the stoker equipment be provided with an adequate safeguard against jamming. This may take the form of a friction clutch, which allows the motor to be freed from the worm ; or a soft metal pin which will shear when an excessive load is applied, and may be easily replaced.

In making arrangements for the installation of stoker equipment, it is essential that ample space is provided in front of the machine to allow for this withdrawal of the worm, and for normal maintenance purposes.

FUEL OIL

On the basis of heat units available per unit of cost, fuel oil is usually more expensive than solid fuels and requires capital expenditure on burning equipment, the interest and depreciation charges of which should be added to the actual fuel costs. Except on large installations little attention is required, and then at infrequent intervals only. Equipments may be automatic, semi-automatic or hand-controlled in their operation, and most installations operate, at least to some extent, by means of thermostatic control governed by room and boiler temperatures.

Storage may be accommodated in any available space, which may be of any shape and at any reasonable level and the supply to the burners arranged through pumps or by gravity, according to the respective levels of storage and burners. Underground storage is quite usual.

In the case of a building to be used as a place of public resort, e.g., theatre, cinema, exhibition hall, and any building for which consent is asked for excess cube, the L.C.C. or other appropriate authority will require compliance with certain conditions relating to the storage and use of fuel oil. In addition the Insurance Office covering the risk will require that their regulations be observed.

TOWN GAS

Gaseous fuel has not been developed to any large extent for central heating services, except for comparatively small installations. This is principally owing to its relatively high cost as compared to solid and liquid fuels in most districts. Its use, however, is increasing, and gas-fired boilers may be obtained suitable for any size of installation. Boilers are usually controlled by thermostat, and waste is reduced to a minimum. No labour is required, except for periodical inspection, and there is no expensive mechanical apparatus to purchase.

Note.—The condense in gas-fired boilers amounts to approximately 5 lb. per 100 cu. ft. of gas consumed.

ELECTRICITY

Electrically heated boilers, both for continuous operation and for use as thermal storage vessels, are advantageous where electricity is available at low rates—and in certain circumstances represent an economic solution of the heating problem. In many districts the supply authority is prepared to furnish current at particularly favourable rates if its use is confined to the periods of minimum demand—usually during the night hours. In such cases the use of thermal storage equipment should be considered.

Electrically heated boilers are invariably controlled by thermostat and their efficiency is very high. In spite of the higher cost of electricity as a fuel—on the basis given for other fuels mentioned—the facts that no labour is required, and no chimney or storage space need be provided and that there is an entire absence of dust are of importance.

FUME CLOSETS

These are required in all laboratories where noxious gases are produced, and consist of glazed compartments constructed usually in teak or pitch pine furnished with special means of ventilation. The flue from each closet must be kept separate from every other flue and taken into the open air, preferably at the top of the building. Sharp bends in the flue should be avoided. The closets are usually fixed on a reinforced concrete slab with encaustic tile or other impervious and acid-proof finish, the top surface of which is about 3′ above floor level. The glazed top to the closet is fixed on the slope, like a lean-to roof, the height above the tiles in the clear being about 5′ at the back and 3′ 6″ at the front. In the case of a single closet the glazed sides may be fixed, but in a range of two or more the intermediate partitions should be removable to accommodate long apparatus. The width of each closet is about 4′ 6″ centre to centre of partitions, and the depth from front to back in the clear is about 2′ 6″.

The front consists of a sliding sash hung with cat-gut, the pulley boxes being carried up to allow a clear opening about 3′ high when the sash is raised. Rubber buffers are sometimes fixed to the bottom rail to ensure a permanent gap of ½″ for ventilation when the sash is lowered, and it is better to provide access to the weights from the front by hinging the outer linings.

The flue should be of ample size and may be of glazed stoneware pipes or glazed brick. Asbestos cement flues of special acid-resisting type can be obtained in either round or rectangular sections and with appropriate bends, cowls, and other fittings.

The draught may be produced by Bunsen flame or by fan ; but if the latter is used it should be so installed that the fumes do not pass through the fan. Where inflammable gases are likely to be present the Bunsen flame should not be used.

GARAGES

The model byelaws issued from the Ministry of Health deal specially with the walls, etc., of small garages. The byelaws of the L.C.C. do not include parallel provisions.

Garage doors should be made a minimum width of 7′ 0″ in the clear when open, but a greater width is desirable. Where they are hinged provision should be made for fixing them when open. Overhead track doors and steel shutters are often used.

In some cases local byelaws require concrete or other fire-resisting floors to living-rooms over a garage unless the floor is sufficiently protected on the underside by a ceiling entirely composed of incombustible material.

In a building in which there is a garage and also a room used as above stated, the stable or garage must be separated

vertically by walls at least 8½″ thick and horizontally so that every part not occupied by a joist or beam has a 3″ thickness of concrete pugging or some other incombustible material and must be properly ceiled by asbestos or similar sheets. All door openings require fire-resisting doors and door frames.

A special gully trap or intercepting chamber should be fitted for the interception of grit, petrol or oil before discharging into the sewer (see sketch on page 55).

In country districts the garage drainage may conveniently be taken to a soakaway pit. Permanent ventilation should always be provided to the garage.

MAXIMUM SIZES OF VEHICLES

The Ministry of Transport's Statutory Rules state that the overall length of a motor vehicle with four wheels shall not exceed 27′ 6″, and that a motor vehicle with more than four wheels shall not exceed 30′. The overall length of an articulated vehicle shall not exceed 33′. (An articulated vehicle means a heavy motor-car with a trailer so attached that a substantial part of the weight of the trailer is borne by the motor vehicle.)

The overall width of a heavy motor car or tractor shall not exceed 7′ 6″. The overall width of a motor car shall not exceed 7′ 2″.

There is no legal limit fixed with regard to the heights of vehicles but the heights of bridges over roads is fixed by the regulations of the Ministry of Transport to a minimum of 16′ in the clear.

Most pantechnicons have an overall height of about 12′ from the ground level, and double-deck buses up to about 14′ 6″.

CAR DIMENSIONS, WEIGHTS, TURNING CIRCLES, SIZES

(New post-war data is not available at time of going to press. Latest details can be obtained from the Society of Motor Manufacturers and Traders, Ltd., 148, Piccadilly, W.1., Grosvenor 4040.)

PRIVATE CARS (1937)

Car	Treasury Rating	Length	Width	Height	Weight Cwts.	Diam. of Turning Circle
Alvis	19·82	15′ 11″	5′ 10″	5′ 8″	35	40′ 0″
Armstrong-Siddeley ...	26·0	15′ 10½″	5′ 10″	6′ 0″	39¾	46′ 0″
,, ...	14·0	13′ 8½″	5′ 4″	5′ 5″	25	39′ 0″
Austin	23·5	16′ 7″	5′ 10½″	6′ 4″	39¼	50′ 0″
,, ...	7·8	9′ 10″	4′ 1½″	4′ 4″	9¼	38′ 2″
Bentley ...	29·4	16′ 0″	5′ 9½″	5′ 2½″	32½	39′ 7″
B.S.A.	10·0	12′ 2″	4′ 9″	4′ 9″	12½	40′ 0″
Buick	37·8	17′ 10½″	6′ 3½″	5′ 11½″	44	48′ 0″
,, ...	30·6	16′ 7½″	6′ 0″	5′ 10¼″	33	39′ 0″
Chevrolet ...	29·4	15′ 7″	6′ 0″	5′ 7″	27	42′ 0″
Chrysler ...	33·8	17′ 10″	5′ 10″	5′ 8″	39½	44′ 0″
Citroen ...	15·08	15′ 5″	5′ 8″	5′ 1½″	24¼	48′ 0″
,, ...	12·8	13′ 9″	5′ 3″	5′ 0″	20½	40′ 0″
Daimler ...	13·7	17′ 0″	6′ 1″	—	32	48′ 0″
,, ...	26·2	14′ 4″	5′ 10½″	5′ 6″	27	42′ 6″
Fiat	6·7	10′ 8½″	4′ 3½″	4′ 7″	10	28′ 6″
Ford	30·01	14′ 11½″	5′ 9½″	5′ 8½″	25¼	40′ 0″
,, ...	7·96	11′ 11″	4′ 6″	5′ 1″	9¾	35′ 0″
Hillman ...	20·92	15′ 10″	6′ 1″	5′ 9″	33½	46′ 0″
,, ...	9·8	12′ 9½″	5′ 1″	5′ 2″	11¾	36′ 0″
Hudson ...	28·8	16′ 10½″	6′ 0″	5′ 9½″	—	45′ 0″
Humber ...	26·88	17′ 6″	6′ 2″	5′ 10″	40¼	47′ 9″
,, ...	11·97	13′ 4″	5′ 2½″	5′ 7″	24½	38′ 0″
Jowett	10·0	13′ 5″	5′ 1½″	5′ 4″	18	36′ 0″
Lagonda ...	29·13	15′ 4″	5′ 9½″	5′ 5½″	36	42′ 0″
Lanchester ...	19·3	15′ 3″	5′ 7″	5′ 8½″	31½	38′ 0″
,, ...	10·8	13′ 10″	5′ 0″	5′ 6″	24	42′ 6″
M.G.	17·7	16′ 5″	5′ 6½″	5′ 5½″	29¾	40′ 0″
,, ...	10	11′ 7½″	4′ 8″	4′ 5″	15¾	37′ 0″
Morris	25·01	15′ 11″	5′ 10″	5′ 8″	29¾	45′ 0″
,, ...	8·05	11′ 9″	4′ 6½″	5′ 0″	13	27′ 0″
Packard ...	32·5	18′ 1″	6′ 2″	5′ 10″	45½	42′ 0″
Riley	14·29	14′ 10″	5′ 1½″	4′ 11″	25½	38′ 0″
,, ...	9·02	13′ 10″	4′ 10″	5′ 2″	20½	35′ 0″
Rolls-Royce ...	50·7	16′ 9″	6′ 6″	6′ 2″	49½	48′ 0″
,, ...	29·4	15′ 11″	6′ 0″	5′ 10″	36	42′ 0″
Rover	19·8	14′ 4½″	5′ 2″	5′ 1″	27½	40′ 0″
Standard ...	19·84	15′ 2″	5′ 4″	5′ 5″	26	41′ 0″
,, ...	8·93	12′ 3½″	4′ 8½″	5′ 2½″	16¾	31′ 0″
Studebaker ...	30·0	16′ 10″	6′ 0″	5′ 7½″	33	40′ 0″
Sunbeam Talbot	23·8	16′ 10″	5′ 9½″	5′ 7½″	42½	45′ 0″
,, ...	9·8	12′ 3″	4′ 10″	4′ 9½″	19	36′ 0″
Vauxhall ...	24·97	16′ 9½″	5′ 11½″	5′ 11″	33½	46′ 3″
,, ...	12·08	13′ 4½″	5′ 4″	5′ 4″	22½	36′ 6″
Wolseley ...	25·01	17′ 10″	6′ 0″	6′ 2″	36½	46′ 0″
,, ...	10·0	13′ 6″	5′ 1″	5′ 4½″	22½	40′ 0″

The following tables of car sizes are intended for use in determining the size of garages. They give the dimensions, weight and turning circle (diameter taken to outer tyre tread) of several makes of cars and commercial vehicles : the dimensions are taken from the "Schedule" published before the war by the Society of Motor Manufacturers and Traders.

The tables below give the pay-load figure : this includes the weight of passengers and body where the number of passengers is given, but does not include the weight of the body in the case of goods vehicles.

COMMERCIAL VEHICLES

Make	Overall dimensions of chassis		Pay Load	Diam. of Turning Circle
	Length	Width	Cwts.	
A.E.C. (4 wheeler) ...	18′ 0″	7′ 5½″	156	50′ 0″
,, (rigid 8 wheels) ...	30′ 0″	7′ 5½″	316	76′ 0″
Albion (4 wheeler) ...	17′ 7″	6′ 2″	30–40	43′ 0″
,, (rigid 8 wheels) ...	30′ 2″	7′ 5″	300	67′ 0″
Austin (4 wheeler) ...	11′ 11″	4′ 8″	10	42′ 2″
Bedford (4 wheeler) ...	19′ 5″	6′ 10″	60	51′ 6″
Carrimore (Articulated 6 wheeler)	33′ 0″	7′ 6″	220	40′ 0″
Dennis (4 wheeler) ...	17′ 0″	6′ 4″	35	37′ 0″
,, (rigid 6 wheeler) ...	26′ 11″	7′ 6″	240	60′ 0″
Foden (4 wheeler)	17′ 0″	6′ 9″	80	40′ 0″
,, (rigid 8 wheeler) ...	28′ 6″	7′ 6″	300	71′ 0″
Fordson (4 wheeler) ...	14′ 4½″	5′ 7″	15	40′ 0″
,, (rigid 6 wheeler)	22′ 5″	6′ 6″	120	66′ 6″
Guy (4 wheeler)	16′ 1″	6′ 4″	40	40′ 0″
,, (rigid 6 wheeler) ...	21′ 4″	7′ 6″	120–140	54′ 0″
Leyland (4 wheeler) ...	17′ 4″	6′ 7″	60	43′ ″
,, (rigid 8 wheeler) ...	29′ 11″	7′ 6″	294	66′ 0″
Morris (4 wheeler) ...	13′ 5″	5′ 9″	15	42′ 0″
,, (rigid 6 wheeler) ...	21′ 2″	6′ 5″	100	60′ 0″
Thornycroft (4 wheeler) ...	17′ 9″	6′ 7″	40	38′ 0″
,, ,, ...	27′ 3″	7′ 5″	145	60′ 0″
Vulcan (4 wheeler) ...	16′ 9″	6′ 5″	15	45′ 0″
Yorkshire (rigid 8 wheeler)	30′ 0″	7′ 5″	297	69′ 6″

PUBLIC SERVICE VEHICLES

Type	Seating	Length	Width	Height	Laden Weight	Diameter of Turning Circle
					tons cwts. lb	
L.T. type (single deck)	35 seats	29′ 9½″	7′ 6″	8′ 8½″	8 14 6	within 60′
S.T. Type (double deck)	50 ,,	25′ 5½″	7′ 6″	13′ 11½″	9 15 3	,, 60′
S.T.L. Type (double deck)	56 ,,	25′ 11½″	7′ 6″	13′ 11½″	9 10 2	,, 60′
L.T. Type (six wheeled double deck)	60 ,,	27′ 3″	7′ 6″	14′ 0½″	11 7 2	,, 60′
London Taxi	—	14′ (max.)	5′ 9″ (max.)	—	—	,, 25′

GAS AND GASFITTER

GAS PRESSURE

On normal pressure systems of supply, gas pressure is measured in tenths of inch water column. The instrument used for measurement is a U-tube containing water to a point midway up each stem. A gas pressure exerted on one of the stems results in a difference of water level in both. This difference is read from the graduated scales marked on the stems, and gives the required gas pressure.

The Gas Regulation Acts of 1920 and the Gas Undertakings Acts of 1929, 1932, and 1934 impose on gas undertakings a minimum of 2″ pressure in their mains, a penalty being imposed if the pressure at any time falls below this figure. In order to ensure a safe margin most companies aim at a minimum working pressure of 3″ to 3½″.

DEFINITION OF A THERM

One therm equals 100,000 British Thermal Units. Under the Gas Regulation Act, 1920, a therm is a measure of the quantity of gas required to produce 100,000 B.T.U.'s on combustion, and is the unit by which gas is sold to the consumer. To find the number of therms in a given number of cubic feet of gas, multiply the declared calorific value of the gas per cubic foot by the number of cubic feet, and divide by 100,000.

SERVICES

A service is the pipe which connects the main to the premises to be supplied. The size of the service varies from 1″ internal diameter for a small house to 12″ or more for industrial buildings and depends upon the consumption of gas required, the length of run and the pressure available. A gas service should not be laid in close proximity to electric cables or motors. The sizes in general use are 1″, 1¼″, 1½″, 2″, and 3″. Where a service is of 2″ or larger diameter a control valve should always be provided outside the premises ; where it is smaller than 2″, but feeds a rising service, a valve should still be fitted outside the premises : if this is not done, a control cock should be installed in an accessible position where the service enters the building. Steam weight tubing must be used for all external work.

METERS

The position of the meter should be such as involves the shortest possible length of service from the main, and should be one having a moderate temperature. Meters should not be fitted in proximity to cables or electrical apparatus, and the main cock or valve for the meter must be near its inlet and easy of access in case of fire or other emergency.

I.G.E. METERS

Meters for domestic purposes are made to standard sizes according to a specification issued by the Institute of Gas Engineers in 1936. The following table shows leading dimensions of these meters :—

Type	Hourly capacity	Size of inlet and outlet	Dimensions of case Height	Width	Depth
	cu. ft.	in.	in.	in.	in.
D.1	100	¾	11¾	8¼	7¼
D.2	200	1	14¾	10¾	9
D.4	400	1¼	18½	14	10¾

These dimensions do *not* include for prepayment attachment, if fitted.

The following tables give dimensions of larger capacity meters, and also of types of domestic meters rendered obsolete by the I.G.E. Specification, many of which will be found still in service. "High capacity" meters are denoted by H.C.

CONNECTIONS TO LEAD

Maximum capacity per hour, feet	Size of case	Classification	Size of caps, linings or bosses	Bore of linings and size of lead	Height to top of unions	Width outside caps	Depth back to front
25	3 lt.	3 lt.	3 lt.	⅝″	15½″	11¼″	8¼″
45	5 lt.	5 lt.	5 lt.	¾″	17″	13″	9⅜″
80	3 lt.	80 ft. pr. hr. H.C.	5 lt.	¾″	15½″	11¾″	8½″
80	10 lt.	10 lt.	10 lt.	1″	19⅜″	14⅝″	11¼″
120	5 lt.	120 ft. pr. hr. H.C.	10 lt.	1⅛″	17⅜″	13¼″	9″
150	20 lt.	20 lt.	20 lt.	1¼″	24″	18½″	14⅝″
210	30 lt.	30 lt.	30 lt.	1¼″	27¼″	21¼″	16⅜″
240	10 lt.	240 ft. pr. hr. H.C.	20 lt.	1¼″	20¾″	15¼″	10⅞″
300	50 lt.	50 lt.	50 lt.	1½″	33″	25½″	20⅞″
360	60 lt.	60 lt.	60 lt.	1½″	34″	27¾″	21⅜″
420	20 lt.	420 ft. pr. hr. H.C.	50 lt.	1½″	24″	19″	13¼″
480	80 lt.	80 lt.	80 lt.	2″	39⅛″	31⅜″	24⅜″
600	100 lt.	100 lt.	100 lt.	2″	42¾″	32⅝″	26″
700	30 lt.	700 ft. pr. hr. H.C.	100 lt.	2″	28″	22¼″	15″

FLANGED CONNECTIONS

				Bore	Height overall	Width over Flanges	Depth
900	150 lt.	150 lt.		3″	51⅝″	39¼″	28″
1200	200 lt.	200 lt.		3″	56⅝″	45″	33″
1200	60 lt.	1200 ft. pr. hr. H.C.		3″	29″	30½″	18⅝″
1500	250 lt.	250 lt.		3″	58½″	45″	33″
1800	300 lt.	300 lt.		3″	63″	48½″	38¼″
1800	80 lt.	1800 ft. pr. hr. H.C.		3″	36½″	35″	22¼″
2400	400 lt.	400 lt.		4″	71½″	56″	41″
3000	150 lt.	3000 ft. pr. hr. H.C.		4″	43½″	39¾″	25½″
3000	500 lt.	500 lt. ...		6″	79½″	58″	46″
6000	250 lt.	6000 ft. pr. hr. H.C.		6″	54″	48″	30¼″
9000	300 lt.	9000 ft. pr. hr. H.C.		6″	63½″	55½″	36½″
15000	500 lt.	15000 ft. pr. hr.... H.C.		8″	68½″	61½″	46″

Sizes of meter compartments are suggested in P.W.B.S. No. 6, "Gas Installations," p. 19. For gas meter only a ventilated compartment 3′ 6″ high, 2′ 0″ wide, and 10″ deep is suggested for domestic purposes.

It should be noted that in London special regulations for the housing of gas meters exist under the London Building Acts (Amendment) Act, 1939, Part X, Sec. 97.

SIZES OF PIPES

The sizes of pipes needed for branch runs for domestic apparatus are shown in the following table : these would be taken from pipes of larger size used in the main carcass :—

Cookers	½″ upwards
Water Heaters :—	
Bath Geysers	¾″ ,,
Multi-point	1″ ,,
Thermal Storage	½″ ,,
Do. (low hourly consumption)	½″
Circulators	¾″
Wash Coppers	½″
Gas Fires	½″
Radiators	⅜″
Gas Irons	¼″
Lighting Brackets	¼″
Lighting Pendants	⅜″

ILLUMINATION

Inverted gas lighting burners of the type in general use are made in the following three sizes :—

GLASS

In view of the fact that glass is manufactured in such a variety of types, thicknesses and qualities it is very important that the correct trade description should be stated in a Glazing Specification. It should also be noted that some of the defects common to glass manufactured some time ago no longer exist in modern manufacture and it serves no useful purpose to refer to them.
It is sufficient to specify : " All glass to be of the manufacture, type, quality and substance specified."
The following are the more general types of glass used in modern building construction :—

POLISHED PLATE GLASS

Plate glass should be used where undistorted vision is necessary and where it is desired to enhance the exterior appearance of buildings.

Thicknesses	Maximum Manufacturing Sizes*	Approx. weight per sq. ft.	Qualities
	In.	lb.	
⅛"–1¼" and 1½" if necessary	⅛–5/32 in. 100 united	2	G.G. The standard for general glazing purposes, shopfronts, showcases, shelves, doors, etc.
	⅛–3/16 90 × 50	2·¾	
	3/16 100 × 72	2·¾	
	¼ 165 × 110	3·¼	
	5/16–⅜ 280 × 130	4·¼–5·¼	S.G. A higher quality for better class work ; standard quality for mirrors.
	½ 156 × 96	7	
	⅝ 156 × 96	8·¾	
	¾ 156 × 96	10·½	
	⅞ 144 × 90	12·¼	S.Q. A superfine grade where a specially high standard is required for mirrors, cabinet work, photogravure or other purposes.
	1 144 × 90	14	
	1·¼ 108 × 72	17·½	

* Maximum manufacturing sizes are not necessarily maximum safe glazing sizes.

The thicknesses stated are normal and subject to tolerances each way. Unless otherwise specified Polished Plate Glass is supplied approximately ¼" thick which is the normal standard thickness for general purposes.
Twin Plate is Polished Plate Glass produced by the latest method in which both surfaces are simultaneously ground and then simultaneously polished, and is characterised by a considerably higher degree of flatness and absence of wave than that previously attained.
The L.C.C. Building Regulations, 1930, for vertical walls, specifies a wind pressure value of 15 lb. per sq. ft. on the upper two-thirds of a building. In a normal exposure, with wind pressure 15 lb. per sq. ft. (or 68.5 miles per hour) the following are *safe glazing sizes :—*

Substance	Safe Glazing Sizes				
	In.	In.	In.	In.	In.
⅜	200 × 84	160 × 94	120 × 120	76 high × any width	76 wide × any height
5/16	160 × 72	130 × 80	100 × 100	63 ,, × ,,	63 ,, × ,,
¼	120 × 58	90 × 70	79 × 79	50 ,, × ,,	38 ,, × ,,
3/16	100 × 41	80 × 46	58 × 58	38 ,, × ,,	38 ,, × ,,

It is generally conceded that the regulations apply to the upper two-thirds of the building, and no shop front window would require such a high standard. A glass to withstand a wind pressure of 6 lb. per sq. ft. or 42 miles per hour should be satisfactory for normal town environment and the following table would apply :—

Substance	Glazing Sizes				Height above ground must not exceed
	In.	In.	In.	In.	In.
⅜	350 × 130	250 × 150	188 × 188	120 high × any length	240
5/16	250 × 112	200 × 128	157 × 157	100 ,, × ,,	220
¼	200 × 90	165 × 100	127 × 127	80 ,, × ,,	200

Polished Plate Glass is also available in various tints. On a big scheme it is advisable to agree a sample.

The following are the standard shades in most general use :—

Pale Blue (a very faint tint).
Standard Blue.
Visor Blue (mostly used for sun visors, but sometimes in silvered form as a contrasting tone).
Pale Green.
Champagne.
Suntint (or Pale Yellow).
Light Amber.
Light Neutral.
Dark Neutral (mostly used for Ambulances).
Rosetint (or Pink).
Amethyst.
Heather (a glass which shows on edge a faint violet tint, but when silvered gives a warm glowing reflection) ; sometimes called Luminor, Enluminor or Glamour.

SHEET GLASS

Blown sheet glass has almost passed out of existence and sheet glass is now manufactured by the flat drawn process which produces an endless sheet which is cut up into sizes for convenient handling.
It has a natural fire-polished surface, but as the two surfaces are never perfectly flat and parallel there is always a certain degree of distortion of vision and reflection.
The thickness of the glass is generally defined by the weight in ounces per sq. ft. and the recognised standard substances are shown in the table below :—

CLEAR SHEET GLASS

Maximum Manufacturing Sizes	Thicknesses	Qualities
18 oz. 72" × 48"	18 oz. approx. 1/12"	O.Q. Ordinary glazing quality. Suitable for general purposes.
24 oz. 84" × 50"	24 oz. approx. 1/10"	S.Q. Selected glazing quality. For glazing work requiring a selected glass above O.Q.
26 oz. 84" × 54"	26 oz. approx. ⅛"	S.S.Q. Special selected quality. For high grade work where a superfine glass is required.
32 oz. 84" × 60"	32 oz. approx. 5/32"	There is also horticultural quality in 24 oz. only. This is an inferior grade suitable only for greenhouse work.

Glass thinner than 18 oz. is made but is not a glazing material, being chiefly used for photographic and scientific purposes. Sheet glass can also be supplied with designs worked upon its surface in enamelled, mechanical embossed, crystalline and other processes. *Thick Drawn* or *Heavy Sheet* is also supplied 3/16" and ¼" substances for use where a glass cheaper and of less good quality than Polished Plate can be accepted for shelves, table tops, transoms, etc.

CATHEDRAL AND FIGURED ROLLED GLASS

A translucent rolled glass, one surface of which has a definite texture or pattern for obscured glazing in bathrooms, kitchens, screens, partitions, doors, leadlights, etc.; also for lighting and decorative effects.

Colours.—White and a wide range of tints, the most popular of which are Green, Amber (or Yellow), Blue and Pink each in a light or dark shade.

Normal manufacturing sizes:—White, 100″ to 120″ × 36″ to 42″; Tinted 96″ × 40″. Certain patterns can be supplied in a width of 48″.

Thickness.—Standard is $\frac{1}{8}$″; certain patterns are also available $\frac{3}{16}$″ and $\frac{1}{4}$″.

ROLLED GLASS

Generally used for roof work and all forms of factory glazing where the extra protection afforded by wired glasses is not required.

ROUGH CAST, DOUBLE ROLLED

A translucent glass produced by rolling molten glass on a table or between rollers. The surfaces are uneven, and direct vision is partly obscured.

Thickness	Approx. weight per sq. ft.	Maximum Manufacturing Sizes
$\frac{3}{16}$″	2 lb. 10 oz.	Up to 120″ × 46″ or 130″ × 26″
$\frac{1}{4}$″	3 lb. 6 oz.	Up to 120″ × 48″ or 144″ × 26″
$\frac{3}{8}$″	5 lb. 1 oz.	Up to 110″ × 48″ or 130″ × 26″
$\frac{1}{2}$″	6 lb. 11 oz.	Up to 110″ × 48″ or 120″ × 26″

THICK ROUGH CAST

This glass is made primarily for grinding and polishing in order to make plate glass. It is used for pavement lights, stallboards, roof lights, illuminated dance floors, and decoratively for table tops, counter tops, etc.

Thicknesses from $\frac{1}{2}$″ to $1\frac{1}{2}$″.

When the glass is being used decoratively it should be borne in mind that it is not really manufactured for that purpose and consequently there are certain features or defects which it is difficult to avoid even by selection. Manufacturing lines, rust marks, variations of pattern from piece to piece and scratches are some of the defects that might be encountered. These have to be taken into consideration when planning a scheme using this type of glass.

PLAIN ROLLED

Also known as *Ribbed Rolled*, *Rough Rolled* and *Hartley's Rolled*. Similar to Rough Cast Double Rolled except that one surface bears a pattern in the form of minute parallel ribs (19 to the inch). Light is diffused in a direction perpendicular to the ribs.

SUBSTANCES

$\frac{1}{8}$″ up to 120″ × 42″
$\frac{3}{16}$″ ,, 140″ × 46″ or 130″ × 26″.
$\frac{1}{4}$″ ,, 140″ × 46″ or 144″ × 26″.

FLUTED ROLLED

Similar to Plain Rolled except that flutes or ribs are larger.

No. 2 Fluted Rolled, approx. 11 to 12 flutes to the inch.

Thickness $\frac{3}{16}$″ approx. Usual maximum sizes 120″ × 42″ or 130″ × 24″.

No. 4 Fluted Rolled. Deeply ribbed with ribs $\frac{5}{16}$″ apart and about $\frac{1}{8}$″ deep (say 3 flutes to the inch).

Thickness $\frac{1}{4}$″ approx. Usual maximum sizes 120″ × 36″.

WIRED GLASS

Has a fine wire netting or mesh inserted during manufacture. When broken, the fragments are held together. Wired glass is valuable for safety purposes and efficient as a means of retarding fire.

Clear and patterned glasses are available.

WIRED DOUBLE ROLLED CAST AND WIRED PLAIN ROLLED

Pattern is as ordinary Double Rolled Cast and Plain Rolled with wire mesh inserted. Hexagonal mesh about $\frac{7}{8}$″. Thickness $\frac{1}{4}$″.

Maximum sizes :—

Wired Double Rolled Cast	140″ × 40″ or 144″ × 26″
Wired Plain Rolled	120″ × 40″ or 144″ × 46″

SQUARE MESH OR GEORGIAN WIRED CAST

Pattern as Double Rolled Cast but with a fine electrically welded $\frac{1}{2}$″ square mesh. Thickness $\frac{1}{4}$″. Maximum sizes 120″ × 40″ or 144″ × 26″.

POLISHED WIRED OR WIRED POLISHED PLATE

A clear glass both sides of which have been ground and polished. It combines the superior appearance of plate glass with resistance to fire and impact. Hexagonal mesh about $\frac{7}{8}$″. Thickness $\frac{1}{4}$″. Maximum sizes 120″ × 40″ or 144″ × 26″.

SQUARE MESH OR GEORGIAN POLISHED PLATE

Both surfaces ground and polished similar to plate glass. For windows, screens, door panels, etc., where appearance is important. Square mesh about $\frac{1}{2}$″ electrically welded. Thickness $\frac{1}{4}$″. Maximum sizes 120″ × 40″ or 144″ × 26″.

GEORGIAN WIRED "VITA"

A translucent glass which is transparent to Ultra-Violet radiation reinforced with $\frac{1}{2}$″ electrically welded square wire mesh. Thickness $\frac{3}{16}$″ approx. Maximum size 80″ × 24″.

WIRED AMBER CAST

Has an irregular surface and gives a pleasant sunshine effect. Hexagonal mesh $\frac{7}{8}$″. Thickness $\frac{1}{4}$″. Maximum size 100″ × 36″.

OPAL GLASS

An opal glass with one or both surfaces ground and polished. Available in certain colours. Black and White are made in $\frac{1}{4}$″, $\frac{5}{16}$″, $\frac{3}{8}$″, $\frac{1}{2}$″, $\frac{3}{4}$″ and 1″. Sizes 100–110 × 48″. $\frac{1}{4}$″ is polished both sides, $\frac{5}{16}$″ and upwards polished one side.

A similar glass "*Marmorite*" is made in Black, White and colours. Standard thicknesses $\frac{5}{16}$″, $\frac{3}{8}$″. Also made $\frac{7}{16}$″, $\frac{1}{2}$″, $\frac{5}{8}$″, $\frac{3}{4}$″, $\frac{7}{8}$″ and 1″.

ROLLED OPAL

A hard and durable opaque glass coloured throughout. One surface has a high gloss or natural fire finish and the other is usually grained or ribbed.

VITROLITE

Is supplied Black, White, and in colours in $\frac{5}{16}$″ and $\frac{7}{16}$″ thicknesses; White and Black also in $\frac{3}{4}$″ and 1″ thicknesses. Usual maximum sizes 125″ to 140″ long, 55″ to 60″ wide, $\frac{3}{4}$″ and 1″ (Black and White only) 100″ to 140″ long × 50″ to 55″ wide.

OPAL SHEET (POT OPAL)

Is a blown sheet glass, white throughout its thickness and having a slight wavy surface. It is manufactured 15–18 oz. and 21–24 oz. Maximum sizes 56″ × 36″.

Opal sheet is also made in certain colours but seldom used.

FLASHED OPAL

Sheet glass on which a thin layer of White Opal is flashed during manufacture. Thicknesses 15–18 oz., 21 oz., 26 oz., 32 oz. Sizes 50″ × 36″.

CROWN GLASS

A transparent glass made in disc form, the bullion being cut from the centre. It has a natural fire-finished surface but is of uneven thickness and with a slight curvature. Crown Glass is no longer manufactured, but imitation Crown Sheet is available in sizes up to 24″ × 16″.

ULTRA-VIOLET RAY GLASS

Vita Glass, very transparent to visible light and transmits a large proportion of the ultra-violet rays of the sun. Can be supplied in :—

Clear Sheet. Similar to ordinary transparent window glass. Usual sizes. Thickness about 1/10″.

Polished Plate. Thickness about $\frac{5}{32}$″.

Cathedral. Semi-transparent surface. Thickness about $\frac{1}{8}$″ and sizes up to about 8′ long.

Wired Georgian Mesh. $\frac{3}{16}$″ thick, sizes 80″ × 24″.

ANTI-FLY GLASS

Research has proved that red or yellow glass acts as a deterrent to the house fly. Of the two, yellow is preferable as the loss of illumination is lower.

A special glass is available, thickness $\frac{1}{8}$″. Maximum sizes 90–100″ × 36–42″. $\frac{3}{16}$″ and $\frac{1}{4}$″ thickness 80–90″ × 36–40″.

PRISMATIC GLASS

A rolled glass, one surface of which consists of parallel prisms which refract light. For use in basements and rooms which have no direct lighting, etc.

Angle No. 1 for situations where angle of obstruction is not more than 30°.

Angle No. 2 for situations where angle of obstruction is between 30° and 40°.

Angle No. 3 for situations where angle of obstruction is over 40°.

Thickness approx. $\frac{3}{16}$″. Sizes 60″ high × 100″ wide.

MAXIMUM DAYLIGHT GLASS

A rolled glass, one surface of which consists of parallel prisms, the other surface being fluted at right angles to the direction of the prisms. It is used for glazing in narrow streets and for lower rooms and basements surrounded by overshadowing structures. It is also used for glazing reflectors to direct light into premises in congested quarters. The flutes act as lenses, concentrating the light, which is then refracted by the prisms at right angles into the room. Supplied in two different angles.

A. Angle — For use where angle of obstruction is not very great—25° to 30°.

B.D. Angle — For use where angle of obstruction is 40° or more.

Substance about $\frac{1}{4}$″. Maximum sizes 100″ × 40″ or 40″ × 100″.

HEAT EXCLUDING GLASS

Non-Actinic and *Calorex* Glass.—Suitable for cold storage, abattoirs, garages, racquet courts, meat markets, etc. Opaque to ultra-violet rays ; eliminates the glare of the sun and much of its heat.

Thickness $\frac{1}{8}$″, $\frac{3}{16}$″, $\frac{1}{4}$″.

Sizes up to 110″ × 24″, 100″ × 36″, 90″ × 42″.

ARMOUR PLATE

Is manufactured by subjecting ordinary glass to a patented toughening process. This treatment greatly increases the mechanical strength and the resistance to large and sudden changes in temperature. It cannot be cut or worked after manufacture, otherwise complete fracture will result.

Thickness	Length	Width
$\frac{3}{16}$″	51″	25″
$\frac{1}{4}$″	70″	52″
$\frac{5}{16}$″, $\frac{3}{8}$″	82″	70″
$\frac{1}{2}$″	82″	70″
$\frac{5}{8}$″	70″	52″

$\frac{3}{4}$″, $\frac{7}{8}$″, 1″, $1\frac{1}{4}$″, can be supplied in sizes up to 8 sq. ft.

TOUGHENED BLACK GLASS

It is recommended that all black glass used for exterior work be toughened to lessen the possibility of breakage due to sudden changes in temperature.

Thicknesses $\frac{5}{16}$″, $\frac{3}{8}$″ and $\frac{1}{2}$″.

Sizes, 82″ × 70″ or strips 110″ long, 9″–18″ wide.

TOUGHENED ROUGH CAST DOUBLE ROLLED

Thickness $\frac{1}{4}$″	Length	70″ × 30″ wide
„ $\frac{3}{8}$″	„	70″ × 52″ „

TOUGHENED SHEET GLASS

18 oz.	14″ × 10″
24 oz. and 26 oz.	24″ × 18″
32 oz.	36″ × 24″

Certain standard patterns and colours of Figured and Cathedral Glass can be toughened in sizes 24″ × 18″–$\frac{1}{8}$″ and $\frac{1}{4}$″ thickness.

PRESSED GLASS

Pavement Lights and Roofing tiles of various types for use in reinforced concrete and certain types of decorative moulded glasses are pressed in moulds.

INSULIGHT GLASS BRICKS

Are hollow and possess partial vacuum, consequently have a high insulating value for heat and sound. Available in the following types.

P.B. 2 — $5\frac{3}{4}$″ × $5\frac{3}{4}$ × $3\frac{7}{8}$″. Surface pattern of $\frac{1}{2}$″ convex ribs carried vertically on both exterior faces and horizontally on both interior faces. Approx. weight 3 lb. 11 oz.

P.B. 2 — Corner brick. Approx. weight 3 lb. 10 oz.

P.B. 32 — $7\frac{3}{4}$″ × $7\frac{3}{4}$″ × $3\cdot\frac{7}{8}$″. Surface pattern of $\frac{1}{2}$″ convex ribs carried vertically on both exterior faces and horizontally on both interior faces. Approx. weight 6 lb.

P.B. 32 — Corner Brick. Approx. weight 7 lb. 10 oz.

P.B. 3 — $7\frac{3}{4}$″ × $7\frac{3}{4}$″ × $3\cdot\frac{7}{8}$″. Surface pattern of $1\frac{1}{4}$″ concave ribs carried on both interior faces running vertically on one face and horizontally on the other. Both exterior faces are smooth. Approx. weight 6 lb.

P.B. 3 — Corner Brick. Approx. weight 7 lb. 10 oz.

The above dimensions and weights are in accordance with B.S. 1207 : 1945 for Hollow Glass Blocks, which also specifies the type of glass to be used.

Glass Bricks are non-load bearing units which will carry their own weight with a wide safety factor up to any practical height, but because of wind pressure and other stresses it is necessary to put an intermediate support in panels over 20′ high or 120′ super.

In calculating quantities allow $\frac{1}{4}$″ for mortar joints and $\frac{1}{2}$″ clearance joint at the top and vertical edges of every panel. A fairly dry and fatty mortar is advisable as the Glass Bricks are non-absorbent. The best mix has been found to be 4 parts (by volume) sand, 1 part portland cement and 1 part hydrated lime mixed fairly dry. The sand should be clean builder's sand free from gravel.

"THERMOLUX" GLASS

Is a laminated glass consisting of two outer sheets of clear glass and a central layer of white or coloured glass fibre. Its properties are light diffusion, heat insulation (that is exclusion of sun heat during hot weather and retention of warmth during cold), obscuration and a high degree of sound insulation. It is important to note that *exact* sizes must be ordered as adjustment by cutting destroys the sealed edge and with it the special properties of the glass.

Thicknesses from $\frac{3}{16}''$ to $\frac{7}{16}''$.

Maximum sizes 144" × 72", 90" × 84".

By cutting the interlayer from differently coloured fibre sheets it is possible to present a design, picture or lettering. The effect may be likened to a translucent pastel drawing, and art thermolux can be used as an alternative to stained glass.

COLOURED GLASS

Colourless glass is called "white," tints and colours are known by numbers. Most colours are obtainable in the Cathedral type, other glasses are manufactured in special colours largely determined by the demand.

"Pot" colours are those in which the colour is solid throughout. "Flashed" colours are obtainable only with Blown glass. The colour takes the form of a very thin film on one side of the glass.

NOTES ON DIFFUSION

The question of light diffusion is important because it not infrequently happens that a glass, having a comparatively low transmission value produces a better light value than that of transparent glass. It should be borne in mind that the texture or depth of cutting will ultimately play an important part in both the light transmission and diffusion of the glass, having regard to its potentiality for collecting dirt and the difficulty of keeping it clean. The use of deeply patterned highly diffusing glasses should, therefore, be limited to cases where a high degree of obscuring is essential. Where absolute smoothness and the maximum degree of diffusion is required the use of flashed opal sheet or "Thermolux" may be necessary; but where it is only desired to prevent vision from a brightly lighted to a comparatively dark area a glass with little or no pattern such as Cathedral, Flemish or Hammered—all of which are easily cleaned—may be adequate; but the effect of artificial light which may reverse the relative intensity of illumination on both sides must not be overlooked.

The extent to which a particular glass will prevent clear vision of objects upon the far side depends not only upon the nature of the surface patterning of the glass but upon the relative illumination on each side. Since the obscuring properties of glass depend upon the capacity of its surface to direct light in all directions, far greater breaking up of the surface of the glass will be required when it is desired to prevent vision of brightly lighted objects from a side in comparative darkness than would be the case if the relative intensity of illumination were reversed.

An entirely false sense of privacy, for instance, is often produced by the fact that the occupant of a room cannot see out in the day time, for the same glass at night with the room illuminated may be almost transparent when viewed from outside a short distance away. Where great obscurity is desired—as in a bathroom—glass should, therefore, either have a very rough and diffusive texture, or be so constructed as to have two distorting surfaces, one of which will act in opposition to the other.

GLASS SILK (OR FIBRE)

Glass silk which consists of fine fibres of drawn glass made up into resilient sheets (very fine fibres have been made into cloth and tape) is used in different forms for thermal insulation and sound-deadening, for both of which purposes it has properties which make it peculiarly suitable. Its thermal conductivity is probably the lowest of any material which can be used for a similar purpose; moreover it is chemically inert, rot-proof, fire-proof, acid-proof (except for hydrofluoric), vermin-proof, and has very durable qualities. It will, therefore, resist any of the usual causes of the failure of insulation. The form generally used for boiler and pipe covering is the sheet, which is supplied in standard lengths 8' 6", widths 3", 4", 6", 18", 27" and 36" and in thicknesses of ½", ¾" and 1". For sound-deadening, glass silk is usually supplied in quilt form, the glass fibres being placed between two layers of tarred kraft paper. It has the advantages of being permanent and non-inflammable; it will neither absorb moisture nor harbour vermin.

The thicknesses in which the quilt is obtainable are ½", ¾" and 1" designated "light" "medium" and "thick"—and in rolls 1 yd. wide by 27" long, each roll being supplied with fixing washers. Acoustically 1" thickness of glass silk gives approximately equivalent absorption to that of 2" of slag wool.

TREATMENT OF GLASS

Glass as manufactured is said to be in "sheets"; when cut to sizes for glazing it is said to be in "Cut Squares" or "Panes." It is usually charged at a price per ft. super and cut squares are charged to the next full in. in the case of fractional sizes. Irregular shapes are charged the squares from which they are cut.

Glass can be bent to almost any required curve; this operation is carried out after cutting to size.

Silvering and gilding can be carried out on almost any glass whether smooth or figured.

Sandblasting and acid-embossing give a variety of textures. Brilliant cutting, bevelling, edge polishing and drilling are also possible on nearly all glasses.

WEIGHT OF GLASS

Whenever possible the thickness of glass is given in fractions of an inch and all rolled glasses are dealt with in this way. Sheet glass, however, is an exception—owing to the fact that the old blown glass was never of uniform thickness throughout the pane, and no dimension of thickness could well be given; consequently the measurement was given by weight, i.e., ozs. per sq. ft. Although modern drawn sheet is of uniform thickness, the traditional method of reference persists.

Useful formulae are :—

For sheet glass.—Each 8 ozs. of weight per sq. ft. represents one millimetre of thickness approx.

For rolled glass.—Each ⅛" of thickness represents 1½ to 2 lb. per sq. ft.

GLAZING

WOOD GLAZING

All rebates should be primed before glazing. The putty for ordinary wood glazing consists of raw linseed oil, whiting and a little red lead for hardening. Glaziers sprigs—small headless nails driven in parallel with the glass and embedded in the top putties—are used for security. Glazing in doors and in high-class screen work should be bedded in wash leather,

rubber, felt, or black ribbon velvet : the glass is secured by means of a wooden bead.

METAL GLAZING

Metallic putty for glazing in metal is composed of raw linseed oil, whiting and black manganese di-oxide. Water hardening rubber mastic is also used.,

SASH AND METAL CASEMENTS

Inside glazing is advisable because :—

(*a*) Original installation is simpler than from scaffolding and

(*b*) the replacement of breakages is simpler.

Figured Rolled or pattern glasses should be glazed with the pattern inside as the undulations are less likely to collect dirt and can be more easily cleaned.

SHOP FRONTS

Outside glazing is advisable because the original installation is simpler and replacements can be effected without causing disturbance to window enclosure. All glazing beads should have a sharp bevel outwards to allow rainwater to run off.

STONE GLAZING

For glazing directly into stonework a putty composed of gypsum, loamy sand and oxide of lead is often used.

PUTTIES

On wood sashes genuine linseed oil putty is best ; there is no necessity to add hardening agents. Rebates should be primed. On metal casements genuine linseed oil putty is not entirely satisfactory as it remains soft for a very long time. Admixtures like red lead, gold size, etc., give varying results and a specially prepared chemical glazing compound guaranteed to go hard is recommended. B.S. 544 : 1934 covers both types of putty. Small metal " stubs " or wire spring clips, pushed into perforations made for the purpose in metal casements serve a similar purpose to " sprigs " used in wood glazing.

Wash leather, ribbon velvet or rubber are not suitable for exterior work as they perish, but any of these can be used for interior doors, partitions, etc.

HABITABLE ROOMS

As regards height of rooms, area of windows, etc., the local byelaws (and local Acts, if any) should be referred to before drawings are completed. The Ministry of Health Model Byelaws give the following requirements for habitable rooms :—

Height, if not in roof, shall be at least 8′ 0″ from floor to ceiling.

Height, if wholly or partly in roof, shall be at least 8′ 0″ throughout at least one half the total area of the room.

Window or windows opening directly into the external air shall have a total area equal at least to one-tenth of the floor area, and have an opening portion equal to at least one-twentieth of the floor area.

The Model Byelaws also require that any habitable room which is "without a fireplace, and a flue properly constructed and properly connected with the fireplace shall be provided with special and adequate means of ventilation by a sufficient aperture or air shaft having an unobstructed sectional area of thirty square inches at least."

Also that every habitable room in which there is a gas fire or other similar apparatus for heating the room shall be provided, for securing the ventilation of the room, with an adequate flue connected with such gas fire, etc., not communicating with any other habitable room and discharging by a chimney.

The byelaws of the L.C.C. contain similar, but not identical requirements. Notably the minimum room height is normally 8′ 6″. This height is still occasionally required elsewhere, but local byelaws outside London will almost always be found to agree with the Model Series.

HEAT TRANSMISSION OF WALLS, ETC.

See special article page 205.

HOT WATER SUPPLY

See Post-War Building Studies, No. 19. " Heating and Ventilating of Dwellings." (H.M.S.O., 1945, Price 2s. 6d. net). for a survey of available methods.

See also Post-War Building Studies, No. 10, " Solid Fuel Installations " for information on this branch.

(See also " Calorifiers " under " Central Heating," p. 35.)

Unless one of the so-called " instantaneous " water heaters is installed, a domestic hot water supply system must be provided with some form of storage cylinder or tank in addition to the boiler or other heating unit. If such storage were not provided, the actual heating unit would need to have sufficient output capacity to deal directly with the maximum demand. Boilers or heaters may be operated by means of solid, liquid or gaseous fuels, or by means of electricity or by a combined system. In all cases the choice must be decided by local conditions and the cost of the various fuels.

The water in the storage vessel may be heated directly by circulation through the boiler, or indirectly by means of pipe coils, radiators or annular cylinders, which in turn are directly connected with the boiler circuit. The indirect system is usually employed when the water contains impurities likely to interfere with the effective operation of the boiler, or when it is desired to couple a heating system with a hot water supply from the same boiler. The whole of the water used with a direct system passes through the boiler, and, as this is where the highest temperature occurs, it is the most likely place for any incrustation or corrosion to take place. With the indirect system, the water used does not pass through the boiler, but through the storage vessel.

When an indirect system is installed, the boiler circuit must be provided with a feed and expansion service in a similar manner to that required for a heating system, consisting of a feed and expansion tank and pipe.

With the increasing use of gas and electricity as heating mediums for hot water services, the thermal storage vessel has been developed to take advantage of the lower rates available in many districts for supply taken during limited hours. These vessels store heat in the water during the period of supply—usually during the night—and the heated water is available as and when required. In some districts the lower rate is available only when the system is left permanently connected to the supply, the water temperature being controlled by means of a thermostatically operated switch.

Combined system.—In cases where the Supply Authority's regulations permit and the cost of current is low, it may be an advantage to instal a combination hot water storage service, utilising the ordinary domestic boiler during the colder months, and an immersion heater in the cylinder of the circulating system at other times.

Care should in any case be taken to ensure that the storage is fully equal to the demands likely to be made on it, especially if the re-charging rate is low. The standard sizes available are suitable for small domestic premises, but where more than

one bath, two basins and a sink are installed, some care should be taken with the selection, and expert advice obtained. The following table is intended to indicate the heating capacity and storage requirements for various sizes of installations, primarily in connection with boiler equipments ; but it will also serve as a guide to thermal storage conditions :—

Number of Taps, Valves or Draw-offs: Baths	Number of Taps, Valves or Draw-offs: Other points	Capacity of Cylinder or Tank Gallons	Diameters of Primary Flow and Return Pipes in.	Heating Power in Boiler in B.T.U.s
1	2	30	1¼	20,000
1	4	40	1¼	30,000
2	4	50	1½	40,000
2	6	60	1½	50,000
3	6	80	1½	60,000
3	10	100	2	80,000
4	8	120	2	100,000
4	15	150	2	120,000
5	10	175	2½	140,000
5	20	200	2½	160,000

To allow for sudden and heavy demands the boiler capacities given above should be increased by about 25 per cent for mansions and flats, and by about 50 per cent for hotels and institutions. Where the water deposits lime to some extent, the primary circulating pipes may be made one size larger.

In many cases it is found expedient or more economical in first cost to instal an instantaneous heater or geyser and omit the provision of a storage vessel. As the consumption for this type of heater is necessarily heavy over short periods, care must be taken to ensure that the service pipes are of ample diameter in the case of gas heated apparatus and that the cables are adequate for an electricity supply. In the latter case the Supply Authority should be consulted before purchase, to make certain that they will allow a heavy load on their mains, as in many districts, owing to the risk of interference with the lighting services, the load which may be applied is strictly limited.

See also "Plumbing," p. 113.

HOUSING

SIZE OF ROOMS

The following sizes of rooms are regarded by the Ministry of Health as affording a desirable standard :—

Type of dwelling	Room	Range of sizes in sq. ft. (including built-in cupboard)
Family dwellings : Kitchen–Living-Room Type	Kitchen–Living-Room	180–200
	Ditto where sitting-room is also provided	170–180
	Sitting-room if provided	110–120
	Scullery washhouse	65–80
	Scullery only	35–45
	Washhouse only	35–45
Family dwellings : Working kitchen type	Living-room where there is no dining space	180–200
	Ditto plus dining space	225–245
	Working kitchen	90–100
Family dwellings : Dining kitchen type	Living-room	160–180
	Dining kitchen	110–125
	Washhouse	35–45
Family dwellings : All types	First bedroom	135–150
	Other double bedrooms	110–125
	Single bedroom	70–80

Type of dwelling or room	Room	Range of sizes in sq. ft. (including built-in cupboard)
Old people's dwellings	Living-room Bedroom	140 (minimum) 120 (minimum)
Bathrooms	Minimum width 4′ 9″	
W.C.	Minimum width 2′ 7″	
Larders	Town Country	4 10
Outside Store		50
Fuel store		12–24
Combined outside store for rural areas		85

See: M.O.H. "Housing Manual," 1944.

ILLUMINATION UNITS

STANDARD UNITS

The *lumen* is the total amount of light intercepted by or falling upon a surface of one superficial ft., every point of which is at a distance of 1′ from a point source having an intensity of one candle.

The degree to which a surface is illuminated is measured in *foot candles*. One lumen will light a surface of 1 sq. ft. to an average intensity of one candle.

The wattage required is dependent on the type of fitting used, the amount of absorption by the fitting, the reflecting qualities of walls and ceilings, the spacing of the units and the height of the units above the working plane.

See special article "Artificial Lighting" on page 12, also Post-War Building Studies, No. 12 "The Lighting of Buildings" (H.M.S.O., 1944. 2s. 6d.) and Handbook No. 2c, issued by The Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.

JOISTS, TIMBER

(See "Carpenter and Joiner," p. 31.)

JOISTS, ROLLED STEEL

(See "Lintels," p. 83 and "Structural Steel," p. 133.)

KITCHEN EQUIPMENT

B.S. 1195 : 1944 provides a range of twenty standard kitchen units of various sizes, designed to provide, in combination, the necessary storage and work-top space for any kitchen, large or small.

The dimensions of the units are based on the following modules :

Width 21″ and multiples thereof.
Depth 21″ and 12″
Height Skirting level 3″.
Work-top level 36″.
Hanging cupboard level 49″.
Dead storage level 81″.
Ceiling level 95″ or 101″.

Floor, wall storage, and full height units are provided, and details of the internal arrangement of cupboards are given.

LAGGING

All exposed heating surfaces, i.e., boilers, hot water storage cylinders, calorifiers and pipes which are not required as heating surfaces should be properly covered with insulating

materials. The amount of heat lost (and fuel wasted) by exposed pipes conveying heat is rarely appreciated. In any ordinary hot water heating apparatus every lineal ft. of 2″ pipe will transmit approximately 1·3 B.T.U. per hour per degree difference between the air and the water temperatures. Assuming the latter to be 160° and 40° respectively the amount of heat lost would be 120 × 1·3 = 156 B.T.U, per lineal ft. per hour. Should the installation consist of 200′ of exposed 2″ pipe not required as effective heating surface, the amount of heat wasted per hour would be 156 × 200 = 31,200 B.T.U., or for a 24-hour day no less than 748,800 B.T.U.—equal over 5½ cwts. of coke per week. In the case of a steam heating apparatus where the temperature of the pipe surface would be considerably higher, the amount of heat lost would be at least 40 per cent greater. It is, of course, impossible entirely to prevent any loss of heat from a heated surface, but the amount lost can easily be reduced by from 80 to 85 per cent.

It is essential that the insulating material should be a really efficient non-conductor of heat, as a poor material may conduct heat from the pipe to its surface at such a rate that the pipe will actually lose more heat when covered than uncovered, due to the fact that the application of covering material greatly increases its circumference.

B.S. 1304 : 1946 standardises "Read-to-fit" thermal insulating materials ; a reasonable standard of thermal performance is assured by specifying a minimum thickness of insulating material based on the manufacturers declared value of conductivity. The following values of thermal conductivity (B.Th.U. per sq. ft. per hour per deg. F. per in. thickness) for various materials are quoted as examples in this Standard :

Material	Density lb. per cu. ft.	Thermal Conductivity
Asbestos	10–12	0·35
Glass fibre	10	0·28
85 per cent Magnesia ...	12	0·42
Hair felt	9	0·27
Wool felt	8½	0·26
Mineral wool	8	0·28
ditto	11	0·30
Slag wool slab	10–13	0·29
Compressed baked cork ...	8	0·33
ditto	10	0·36
Granulated cork (raw) ...	5½	0·33
ditto	7½	0·36
ditto (baked)	6¼	0·31

Note.—The above thermal conductivities are measured between a hot face at 180°F. and a cold face at 70°F. The thermal conductivity decreases as the temperature is lowered. These materials are equally suitable for pipe insulation against the effects of frost.

LEAD

(See "Plumbing," p. 113.)

LIBRARIES

LIBRARIES AND LIBRARY SHELVING

(See "E. and O.E.," the Architect and Building News, August, 1934, to November, 1934.)

LIBRARY STACK ROOMS

Height.—Book stacks are generally 7′ 6″ in height measuring from the top surface of one deck to that of the next.

Staircases.—Staircases leading from one stack level to another should be 2′ 6″ in width. If spiral staircases are used, the well opening should be at least 4′ 3″ in overall diameter.

Aisles.—The main aisles should be from 3′ 0″ to 5′ 0″ wide, and those between ranges from 2′ 0″ to 2′ 6″.

Ranges.—The lengths of ranges may be as required but in multiples of shelf length with a maximum of 30′ 0″ for free-ended stacks, and of 12′ where the ends of stacks butt against a wall. A uniform length of shelf should be used throughout any one scheme. The depths of single-faced ranges are from 8¼″ to 12½″ for books, 18¼″ and 22¾″ for newspapers, and for double-faced ranges from 16½″ to 24¼″ for books, 37″ and 44¾″ for newspapers.

Shelves.—Generally the length of the shelves is about 3′.

Special Shelving.—Bound newspapers, extra large folios, prints and maps require special shelving, as they should be kept flat to avoid possible damage to bindings.

Capacity of Shelves.—The number of volumes that can be stored per lineal ft. of shelving depends on the character of the books. The following table, based on a stack height of 7′ 6″ with seven rows of shelves—six adjustable and one fixed in the height—may be useful in computing the amount of stack necessary.

Kind of Books	Vols per ft. of Shelf	Vols per lin. ft. of single-faced range
Circulating	10	70
Fiction	9	63
Economics	9	63
General Literature	8	56
Reference	8	56
History	8	56
Technical and Scientific	7	49
Medical	6½	45½
Law	4½	38½
Public documents	6	42
Bound periodicals	5½	38½

UNIT STACK WEIGHTS

Books weigh about 25 lb. per cu. ft. of ranges, or about 15 lb. per ft. run of 7″ shelving.

Foolscap size box files filled with printed matter weigh about 10 lb. each, or 40 lb. per ft. run of box filing.

Stack Construction.—The weight of stacks may be taken at 5 lb. to 8 lb. per cu. ft. of ranges.

FIRE PROTECTION

The contents of libraries are frequently not only valuable, but actually irreplaceable ; special attention should, therefore, be paid to fire protection. The use of chemicals or water, either automatically or by hand apparatus, may do considerable damage. A system of properly controlled watchmen is probably the best form of protection that can be devised.

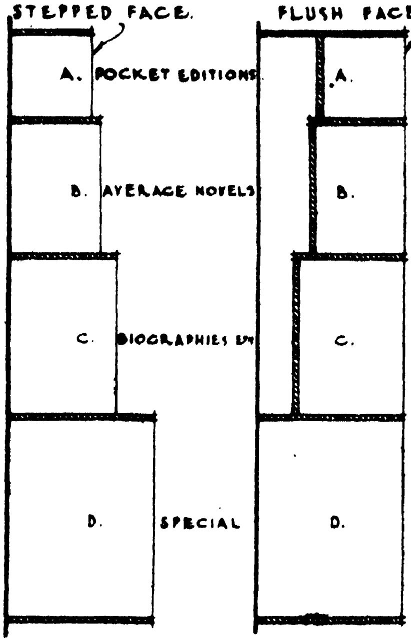
LIBRARY ASSOCIATION

Reference should be made to the Library Association, Malet Place, W.C.1., for advice on the planning of any large scheme.

BOOK SHELVES FOR DOMESTIC WORK

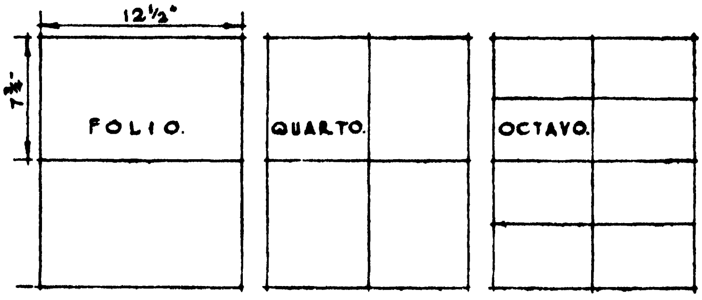
The diagram on the following page shows an arrangement of shelving for books of varying sizes, also a list of paper and book sizes. The terms Folio, Quarto, and Octavo are sub-divisions of a sheet of paper. For instance Folio size of Foolscap is 13½″ × 8½″—the Foolscap sheet being 13½″ × 17″. It is desirable that the lowest shelf should be raised some 4″ above floor level by a recessed base to allow toe-space to users.

DATA FOR BOOKSHELVES AND BOOKCASES.



SUITABLE BOOKSHELVES FOR DOMESTIC WORK:

	DEPTH.	HEIGHT.
A.	5"	7½"
B.	5½"	8"
C.	6½"	9½"
D.	9"	12"



BOOKS USUALLY PRODUCED IN THREE GENERAL SIZES KNOWN AS: OCTAVO (8VO): QUARTO (4TO): FOLIO (2°).

TRADE NAMES AND USUAL DIMENSIONS OF PAGE SIZES UNCUT.

	FOLIO.	QUARTO	OCTAVO.
POT.	12½ X 7¾"	7¾ X 6¼"	6¼ X 4"
FOOLSCAP.	13½ X 8½"	8½ X 6¾"	6¾ X 4¼"
POST.	16 X 10"	10 X 8"	8 X 5"
CROWN.	15 X 10"	10 X 7½"	7½ X 5"
DEMY.	17½ X 11¼"	11¼ X 8¾"	8¾ X 5⅝"
MEDIUM.	19 X 12"	12 X 9½"	9½ X 6"
ROYAL.	20 X 12½"	12½ X 10"	10 X 6¼"
DOUBLE POT.	15½ X 12½"	12½ X 7¾"	7¾ X 6¼"
DOUBLE FOOLSCAP.	17 X 13½"	13½ X 8½"	8½ X 6¾"
SUPER ROYAL.	20½ X 13¾"	13¾ X 10¼"	10¼ X 6⅞"
DOUBLE CROWN	20 X 15"	15 X 10"	10 X 7½"
IMPERIAL.	22 X 15"	15 X 11"	11 X 7½"
DOUBLE POST.	20 X 16"	16 X 10"	10 X 8"

LIFTS

The efficiency of the lift installation has a direct influence on the letting value of a building. Experience has shown that in the average office building it is required to move from one-third to one-half of the total number of occupants in about 20 minutes during the rush periods. The approximate number of occupants of an office building may be estimated on the basis of 60 sq. ft. of floor space per person. It is desirable that the interval between trips should not exceed 30 seconds, and sufficient lifts should be installed to provide a service on this basis. No building depending to any extent on its lift service should be equipped with less than two lifts, each capable of maintaining an adequate service in case of the temporary failure of one lift.

Modern lifts are usually of the high-speed self-levelling type with geared or gearless drive. A speed of 500′ per minute is possible, but is undesirable unless the travel is over 80′: a usual speed of 300′ per minute. Where self-levelling gear is not used, at least two or three speed controls should be provided to enable the operator to stop level with the respective floors.

Goods lifts are seldom required to travel at speeds in excess of 150′ per minute.

CONTROLS

The controls may be in the care of an attendant or be automatic. When automatic controls are installed, additional safeguards are necessary to ensure that no gate or door can be opened unless the car is opposite.

Passenger-control has not been found satisfactory in large office buildings, particularly where there are a number of different tenancies.

Motors and gears should preferably be placed above and directly over the lift well. Offset drives should be avoided as they tend to cause heavy wear on the ropes. Gears mounted below entail a heavier load on the structure than when mounted above.

WELL SIZES

For preliminary purposes the well size may be taken as the car size plus 1′ in each direction to allow for guides and balance weights. The actual dimensions vary considerably with the type of lift and the number accommodated in a common well. See references below.

CAR SIZES

The space required per passenger is from 1½ to 2½ sq. ft. and the car should not be generously planned unless the winding gear is of sufficient capacity to deal with the maximum number that the car is capable of carrying. A lift may be intended to carry 10 persons only, but if the car is capable of accommodating 15 persons then that number will at times attempt to travel in it, and the motor may be unable to deal with the overload.

HOSPITAL LIFTS

Lifts for hospitals and nursing homes may be required to accommodate either a stretcher with attendants, a wheeled invalid chair, or a coffin. An internal cage size 7′ 0″ × 3′ 0″ is desirable with 6′ 8″ × 2′ 6″ as an absolute minimum.

CALCULATIONS FOR LIFTS

Let P = the number of persons to be moved.
C = time interval of the trips in minutes.
T = time in which evacuation is to be completed in minutes.

$$\text{Then number carried per trip} = \frac{P \times C}{T}$$

Example :—The total number of persons in a building is 960. How many persons must be carried each trip if one-half of the total number is to be moved in 20 minutes and the time interval between the trips is 30 seconds ?

$$\frac{960 \times \cdot 5}{2 \times 20} = 12{\cdot}1 \text{ persons per trip.}$$

The movement in the rush period is normally in one direction only, hence the lift stops in one direction and runs full speed in the other, giving an average speed per trip of approximately two-thirds the rated speed. An allowance of two seconds must be made for each passenger, 16 to 20 seconds for terminal floor slowing, etc., and 8 seconds for landing.

Let the speed be 300′ per minute and the total travel 100′. The time interval is 30 seconds and the number of persons moved per trip is 12. There are 8 floors :—

Average travel speed = 2/3 × 300 = 200′ per minute.

100′ of travel will take	30 seconds
12 persons at 2 seconds each	24 ,,
Time lost at landings (8 seconds each) ...	64 ,,
Time lost at terminals	16 ,,
Total time	134 ,,

To maintain a time interval of 30 seconds would, therefore, require a battery of at least four lifts.

References :

(1) " Code of Practice for Electric Passenger and Goods Lifts and Escalators." Building Industries National Council, 1943.

(2) P.W.B.S. No. 9. " Mechanical Installations." H.M.S.O., 1944. 2s. 0d.

(3) L. W. Honey : " Lifts," Marryat and Scott Ltd., 40 Hatton Garden, E.C.1., 1946.

LIGHTING

See " Artificial Lighting," page 12.

LIGHTNING CONDUCTORS

Lightning conductors are sometimes erroneously thought to be attractors. They act as conductors of current in the same way as rainwater pipes act as conductors of rain.

Lightning does not always strike from immediately overhead in a vertical direction : if it did, the highest part of the building would be struck. It may strike obliquely from any direction, and a lower part, such as a gable apex, might be nearer to the point in the cloud from which the flash emanated than a higher part such as a chimney stack not very far away.

A point on a conductor acts as a kind of safety valve, dissipating an electric charge and reducing the liability of the flash to strike that part of the structure where the point is fixed. Multiple points—sometimes called " crowsfeet "—are regarded as orthodox. They are suitable where only one conductor is fixed ; but when a number of rods are fixed on a structure fitted with a lightning conductor system, a very unsatisfactory appearance is caused. In a system containing several conductors which are connected together, multiple-pointed rods are not necessary : single points will be equally effective and less unsightly. By setting short points on the exact spots that lightning would be liable to strike, an expert can protect a building effectively by a conductor system which is almost invisible.

Copper is generally used for lightning conductors in this country : iron has been suggested as an alternative material, but it is not sufficiently durable and is more expensive. The form now used is copper band—generally called copper tape—which is not only the most durable but preferable in appearance to any other type. So long as a conductor is sufficiently large not to be fused by a flash—and ¾″ × ⅛″ is in this respect very greatly on the safe side—no advantage is gained by increasing the size.

Where an interconnected system is applied—in which a flash, on striking any point, is distributed over several paths to earth—the copper tapes may be of smaller size without loss of efficiency. An interconnected system for example, which had three paths to earth would, if of copper tape measuring ½″ × ⅛″, be equivalent to 1″ × ⅛″ for the greater part of the course, increasing to 1½″ × ⅛″ in the main conductors to earth.

A conductor should provide a line of low resistance to earth. Great care should therefore, be taken in the making of all joints along the path which it is intended the flash shall follow : they should be carefully soldered as well as being riveted, or they will develop resistance in time. The lower part of the conductor should, where necessary, be protected from possible damage by encasing in iron pipe to a height of 12′ from ground level.

As the earth connection can only be made by contact it is necessary that the connection should be to a well-conducting soil. Dry soil, sand and chalk are bad conductors : water, wet soil—and especially wet clay—are good ; but even in a wet position it is necessary to have a large extent of metal surface in contact with the water or soil to obtain a sufficiently low resistance. This is achieved by terminating the conductor underground with a copper earth plate, the standard size of which is 3′ by 3′, giving a total area of 18 sq. ft. of contact with the earth. A plate 2′ by 2′, giving only 8 sq. ft. of contact, would offer considerably more than double the resistance, and would be inefficient for this reason. The earth connection can be made to a water supply pipe which is in constant use. Thickness of plate makes practically no difference in the resistance, and it is therefore unusual to have the plate more than 1/16″ thick.

All metals in and on a building are conductors, and care must be taken in devising the lightning conductor system to keep well away from those metals to which it may be deemed inadvisable to connect. For example, to use the steel-frame of a building as part of the conductor system might result in a good enough path in the first instance, but might prove disastrous a few years later. The connections in such frames are made mechanically but not electrically good, and are sure to develop high resistance in time.

If a lightning conductor system is allowed to get out of order and fails when struck, the resulting damage may prove serious. Periodical inspections and tests should, therefore, be made by an expert, who would be able to detect and rectify any fault before the system became ineffective.

LINTELS

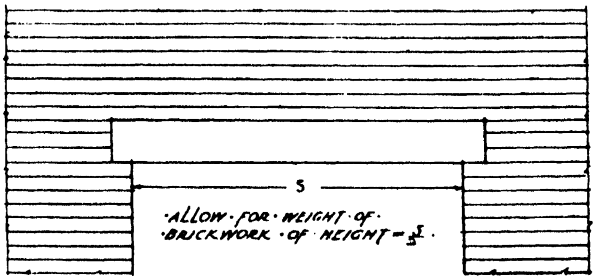
In many cases the brickwork over an opening corbels itself, and only a small load is carried by the lintel.

The lintels in all the cases shown below are assumed to be the

full thickness of the wall in width and formulae given apply only to new work.

Figure 1

Shows a lintel in the middle portion of a wall, or one of a series of lintels :—



·FIG·1·

Figure 2

Where one end of the lintel is close to the end of the wall, the load on the lintel should be taken as the full weight of brickwork of height equal to the span, unless the actual height of brickwork over is less than this :—

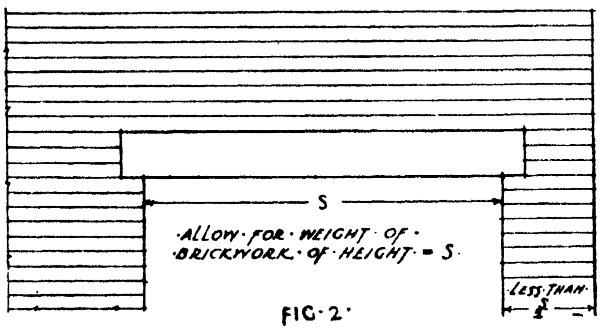


Figure 3

Where both ends of the lintel are close to the ends of the wall, the load should be taken as the weight of the full height of brickwork over the lintel :—

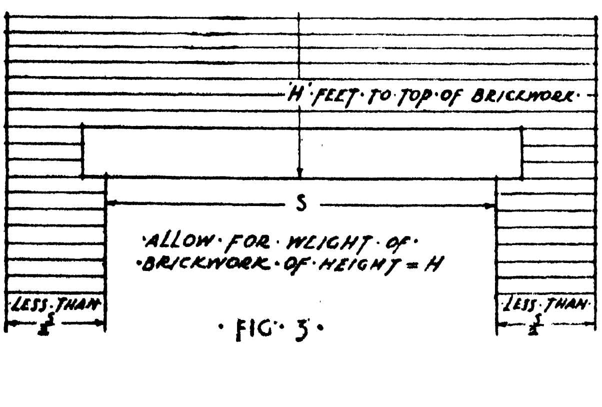
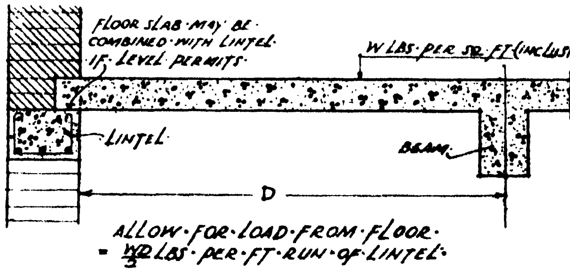


Figure 4

Where the floor slab or floor joists rest on a lintel or on the brickwork above a lintel, the additional load to be allowed per ft. run of lintel equals $\frac{WD}{2}$, where W = dead load + live load per sq. ft. of slab.



·FIG·4·

Figure 5

Where rafters are over a lintel, the load from the roof is usually transferred to the lintel by means of a wall-plate. With no overhang at the eaves the wall-plate and purlin will each take half the load on " D." Taking the total load on the roof slope as 37½ lb. per sq. ft. (inclusive of wind) as the basis, the load on wall-plate with no overhang $= \frac{37 \cdot 5D}{2}$ lb. per ft. run. With overhang at eaves equal to ⅓D (as shown on diagram) the wall-plate will carry two-thirds of the load and purlin one-third.

Load on wall-plate = 25D lb. per ft. run.

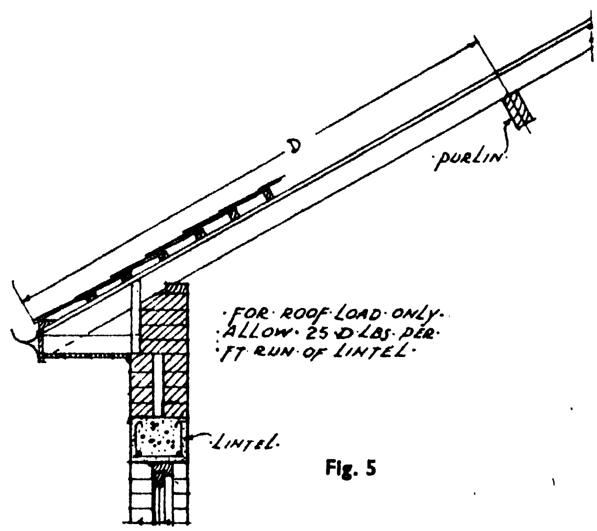


Fig. 5

The above formulae give maximum loads which occur when the rafters are in short lengths stretching from wall-plate to purlin only. Where the rafters are in one length from wall-plate to ridge these figures err on the side of safety by about 10 per cent.

It is improbable that an overhang of more than ⅓D would occur in practice.

Where a concentrated load—such as a roof truss or a main beam—rests on a lintel, the equivalent uniformly distributed load should be calculated and added to the other loads carried by the lintel.

PRE-CAST LINTELS

Reinforced concrete lintels when pre-cast should have the top side clearly marked to avoid the risk of placing them the wrong way up.

Twin lintels with provision for external weathering and for a lead damp course are preferable for use in cavity walling.

Solid lintels are admissible only where they are protected by eaves or similar projection.

STEEL JOIST LINTELS

Where rolled steel joists carry walling it is often better to use two joists bolted together, and of equivalent section moduli than one larger joist, as the two distribute the load better and also give a wider bearing for the wall. The deflection should be calculated. The depth of steel beams should not be less than 1/24th the span, where they are loaded to their full safe carrying capacity.

LOADS ON STRUCTURES

LONDON AREA

The former provisions of the London Building Acts and the London County Council Reinforced Concrete Construction regulations are now replaced by byelaws made by the London County Council, in virtue of the London Building Acts Amendment Act, 1935 and 1939, to which reference should be made for details.

OUTSIDE LONDON

Parallel provisions, but on the whole less detailed, will be found in the byelaws made by local authorities outside London, in substantial conformity with the Model Byelaws issued from the Ministry of Health.

CODES OF PRACTICE

In addition, this subject has been dealt with from the purely scientific basis in publication of the Codes of Practice Committee, established under the aegis of the Ministry of Works.

WIND PRESSURE

For free standing walls such as garden walls (not retaining walls), and for wide glass areas, a minimum wind pressure of 30 lb. per sq. ft. of exposed surface is usually allowed in calculation.

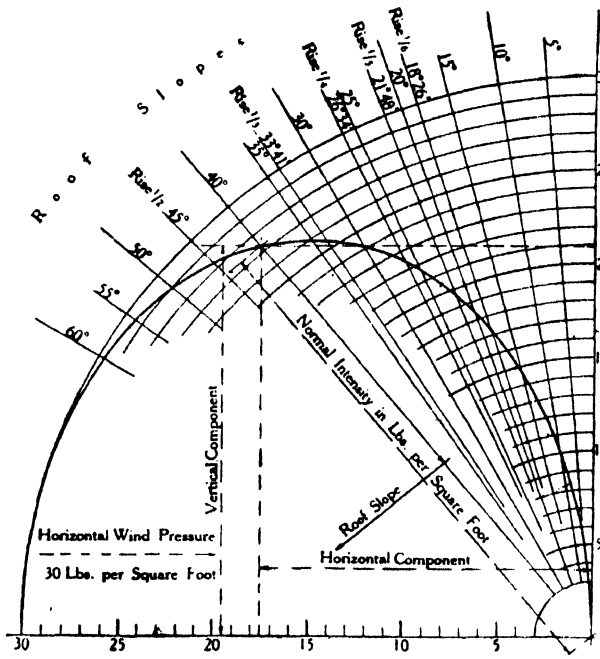
WIND PRESSURE TABLE

Description of Wind	Speed m.p.h.	Pressure per sq. ft. of vertical surface
Fresh breeze	10	5 lb.
Gale	45	10 lb.
Hurricane	80	32 lb.

In England a velocity of 100 miles per hour has been recorded, giving a pressure of 50 lb. per sq. ft., of vertical surface.

WIND PRESSURE DIAGRAM

The following diagram gives the normal component on a sloping surface, due to a horizontal wind pressure of 30 lb. per sq. ft. reduced in accordance with Duchemin's formula :— Normal Pressure = Horizontal Pressure $\times$ 2 Sin a $\div$ (1 $\times$ Sin$^2 a$) where a is the angle of slope. The vertical and horizontal components of this normal pressure can be scaled from the diagram.



LBS. PER SQUARE FOOT.

Example :—For a roof slope of 40° and a horizontal wind pressure of 30 lb. per sq. ft., the pressure normal to this slope is found to be 27·33 lb. per sq. ft. The horizontal component is found to be 17·50 lb. per sq. ft. and vertical component 20·90 lb. per sq. ft. The pressure in lb. per sq. ft. = Square of wind velocity in miles per hour, approx. $\times$ ·0032.

MASONRY

ASHLAR

This is the term generally used for finely dressed stonework.

DEPTH OF BED

For ashlar facings this is usually 4½″ and 9″ on alternate courses, but greater depth is desirable on buildings of permanence.

EXTERIOR FACING SLABS

Buildings may be faced with thin slabs of uniform thickness, secured by metal corbels and cramps.

GRANITE SLABS

These are usually 4½″ thick for exterior wall facings, but where used for stall boards or shop surrounds they are sometimes 1½″ to 2″ or so in thickness. The wall facing slabs, after being fixed by cramps, should be grouted up solid behind with white cement mortar.

MARBLE SLABS

These are usually ¾″ to 1¼″ in thickness and are secured to the wall by means of cramps. A cavity should be left between the wall face and the back of the marble for a free circulation of air, but cills and other thicker stones should be bedded solid in cement mortar.

Interior facing slabs are usually ¾″ thick ; greater thickness may be called for in the case of large slabs, or in the case of stones which are to be fixed in special positions, such as soffits of openings. The slabs are bedded to the wall by plaster dabs, and secured in position by means of small brass or copper cramps (leaving ½″ air space). These cramps are inserted into holes and sinkings into the top bed of the slab, the bottom edge being held in position with " S " hooks. The cramps and the " S " hooks are set into the slab with plaster, the cramps being also tied into the brickwork. A ½″ cavity should be left between the marble and the brick wall, to enable the air to circulate, and to provide for the evaporation of the moisture from the material used in fixing.

It is advisable to shellac the backs and edges of marble slabs, whether used internally or externally, to prevent stains coming through from behind. This applies particularly in the case of light coloured marbles.

Precautions should also be taken to keep heaps of damp materials—such as putty, mortars, sand, etc.—away from walls or other surfaces which are to be faced with marble. The moisture absorbed by the wall may not have had time to dry out before the marble is fixed ; with the result that staining will occur.

MARBLE FLOORING

(See " Flooring," p. 67.)

ARTIFICIAL STONE AND SLABS

These should be similar in bed to natural stones and any slabs under 3″ in thickness should be reinforced. After fixing, care should be taken to see that the bedding material is washed off the face of the stone while still green. It is important to specify that cast stone should have ample time to mature after casting before being finished off. Five or six weeks should be allowed before delivery.

See B.S. 1217 : 1944 " Cast Stone."

MORTARS

For stone work the usual mortars for bedding and grouting are :—

Rubble walling ...	4 sand, 1 portland cement, 1 hydraulic lime.
Ashlar. Bedding joints	3 stone dust, 1 lime putty.
Grouting	1 portland cement, 1 sand (or stone dust).
Granite	1 portland cement, 3 sand
Marble floors ...	1 lime mortar, 3 sand
Marble wall linings	Plaster of Paris or Keene's cement

Where stones are supported by steel work it is advisable to grout up all interstices with 1 portland cement, 1 sand. The use of white portland cement minimises the risk of staining at the joint surfaces. To prevent surface staining on stonework, the backs and beds of all stones should be painted with a bituminous or other suitable protective covering.

SAFE LOADS ON MASONRY

	Tons per sq. ft.
Coursed and squared Rubble	5–10
Ashlar :—Granite	30–50
Sandstone	15–25
Limestone	10–15

The following Table shows tests made by Baldwin-Wiseman and is abstracted from the " Geology of Building Stones " by J. A. Howe :—

Stone tested dry	Transverse Breaking Strength		Crushing Strength	
	Tons per sq. ft.	Lb. per sq. in.	Tons per sq. ft.	Lb. per sq. in.
Grey Granite	174·4	2,712	382·56	5950
Red Granite	92·4	1,437	352·4	5480
Portland	93·1	1,448	262·4	4080
York	72·3	1,124	546·6	8480
Bath	39·2	609	73·3	1140

YOUNG'S MODULUS OF ELASTICITY

For building stones and other similar materials there is no definite value for Young's Modulus. The materials are not truly elastic and a straight line relationship between stress and strain does not exist due to the creep of the material as the load is applied.

It is possible, however, for comparative purposes to give purely arbitrary values for the relation of stress to strain for a pre-determined stress condition. The range given below was supplied by the Building Research Station, and was determined on the building stones at a stress of 500 lb. per sq. in. (32 tons per sq. ft.) in both dry (dried at 50°C.) and wet (soaked at 16°C.) condition. The stones were loaded in a direction perpendicular to the bed.

Stone	" E " lb. per sq. in. (dry)	" E " lb. per sq. in. (wet)
Portland stone ...	4,800,000 to 8,400,000	4,000,000 to 8,100,000
French Stone ...	5,100,000	4,900,000
Other Lime Stones	1,100,000 to 5,100,000	800,000 to 4,900,000
Sand Stones ...	1,300,000 to 1,700,000	600,000 to 1,000,000

L.C.C. Byelaws, 1938, made under L.B. (Amendment) Act, 1935 :—

The use of stone as a building material is permitted under by-law 18 which requires that any stone so used shall possess a crushing strength of at least 1,500 lb. per sq. in. and be free from cracks, sandholes or other defects detrimental to its strength or permanence.

WEIGHTS OF STONE

(See " Weights of Materials," p. 155.)

References :

Warland, E. G., " Modern Practical Masonry." Batsford, 1929. 25s.

Warnes, A. R. " Building Stones." Benn, 1926. 16s.

Nichols, T. B. " An Introduction to Masonry." English Universities Press, 1936. 4s.

P.W.B.S., No. 18. " The Architectural Use of Building Materials." H.M.S.O., 1945. 2s. 6d.

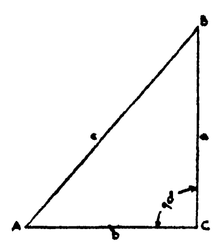
B.S. 1232 : 1945. Natural Stone for Building.

MATHEMATICAL DATA AND TABLES

SOLUTION OF TRIANGLES

Area

Area of triangle = Base × ½ perp. height.



· FIG · 1 ·

Trigonometrical Ratios :—
In Fig. 1 (right-angled triangle) :

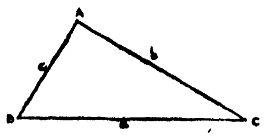
$$\text{Sin } A = \frac{a}{c},\ \cos A = \frac{b}{c},\ \tan A = \frac{a}{b}$$

$$\text{Sec } A = \frac{c}{b},\ \text{cosec } A = \frac{c}{a},\ \cot A = \frac{b}{a}$$

Length of Sides :
and $c^2 = a^2 + b^2$

from which $a = \sqrt{c^2 - b^2}$, $b = \sqrt{c^2 - a^2}$, $c = \sqrt{a^2 + b^2}$

In any triangle : (as Fig. 2).



·FIG·2·

$$\frac{a}{\text{Sin } A} = \frac{b}{\text{Sin } B} = \frac{c}{\text{Sin } C} \quad \text{(Sine rule)}$$

and $a^2 = b^2 + c^2 - 2\,bc \cos A$ (Cosine rule)

$$\text{and } \tan\frac{B - C}{2} = \frac{b - c}{b + c}\tan\left(\frac{B + C}{2}\right)^2 \quad \text{(Tan rule)}$$

Also, $a = b \cos C + c \text{ Cos } B$,

$$\text{and Sin}\frac{A}{2} = \sqrt{\frac{(s - b)(s - c)}{bc}}$$

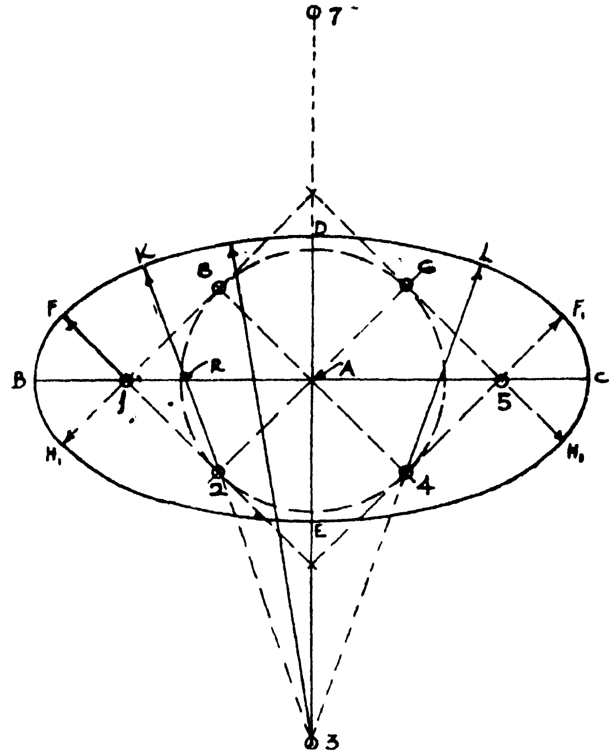
where, $S = \frac{1}{2}(a + b + c)$

Any oblique-angled triangle may be solved by using these formulae. Suggested applications are :—

Given (Fig. 2)	Required	Formula
A, b, c	B.	Use Cosine Rule and Sine Rule, or Tan formula and Sine Rule, or $\text{Tan } B = \frac{b \text{ Sin } A}{c - b \text{ Cos } A}$
A, a, c	C	$\text{Sin } C = \frac{c \text{ Sin } A}{a}$ (Sine Rule)
A, C, a	c	$c = \frac{a \text{ Sin } C}{\text{Sin } A}$ (Sine Rule)
		Where $s = \frac{1}{2}(a + b + c)$
a, b, c	A.	$\text{Tan } \frac{1}{2} A = \sqrt{\frac{(s - b)(s - c)}{s(s - a)}}$

ELLIPSES

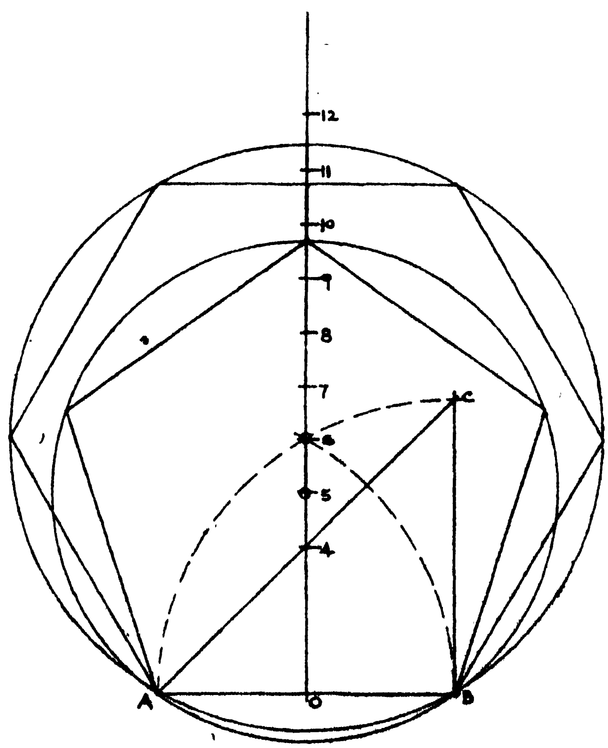
To set out an ellipse, given the dimensions of the major and minor axes :—In the given figure AB and AD are the semi-major and semi-minor axes. From B set off a distance along the major axis, BR, equal to AD. With radius AR describe a circle having its centre at the intersection of the axes—point A. Draw lines at 45° to BC and tangential to the curve of the circle as shown dotted in the figure ; also the lines 8–4, 6–2. Produce the minor axis above and below as shown, making the distances A–7, A–3 each equal to 1–5 (the diagonal of the square). Commence at centre No. 1 and stop this portion of the curve at points F and H. With centre No. 2 and radius 2–F, draw the next portion of



the curve to point K which lies in the same line as points 2 and 3. With centre No. 3 and radius D–3, draw the next portion of the curve from K to point L, and continue with the other centres in a similar manner.

REGULAR POLYGONS

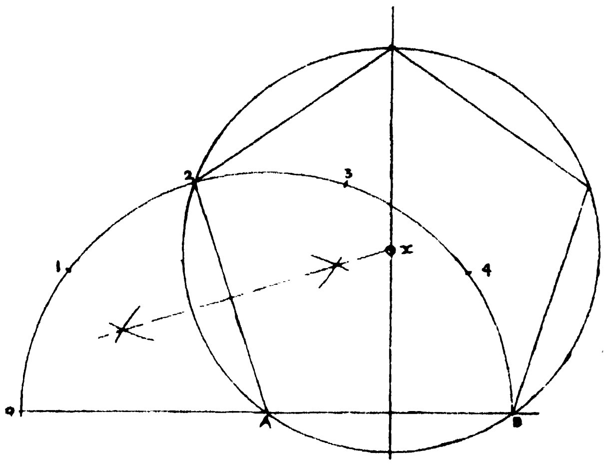
To construct any regular polygon on a given side AB. Method No. 1 (See Figure). The given line AB is bisected



·METHOD·Nº I·

at point O, whence a perpendicular to AB is drawn of indefinite length. Draw BC also perpendicular to AB and of similar length, and join AC which cuts the perpendicular from point O at point 4. This point is the centre of a square described on AB. With B as centre and BA as radius describe the quadrant ABC. The curve cuts the perpendicular from O at point 6, which is the centre of a hexagon described on AB. On the perpendicular from O cut off parts equal to 4–5, 5–6, and number them as shown. These points are the centres of the other regular polygons. The diagram shows a pentagon and a hexagon described in this way.

Method No. 2. (See corresponding figure.)



·METHOD· No 2.·

Produce AB to O. With centre A and radius AB describe a semi-circle. Divide the semi-circle into as many equal parts as the polygon has sides. The point A is joined with the second division for any polygon and gives the second side. Bisect this side and also AB to find the centre x of the required polygon. The diagram shows a pentagon found by means of this method.

POUNDS AS DECIMALS OF A TON

1 lb. = ·00044643 ton.   ·001 ton = 2¼ lb.

lb.	tons	lb.	tons	lb.	tons
1	·0004	80	·0357	3000	1·3393
2	·0009	90	·0402	4000	1·7857
3	·0013	100	·0446	4480	2·0000
4	·0018	110	·0490	5000	2·3321
5	·0023	112	·0500	6000	2·6786
6	·0027	120	·0535	6720	3·0000
7	·0031	130	·0580	7000	3·1250
8	·0036	140	·0624	8000	3·5714
9	·0040	150	·0679	8960	4·0000
10	·0044	160	·0714	9000	4·0179
11	·0049	170	·0758	10000	4·4643
12	·0053	180	·0803	11000	4·9107
13	·0058	190	·0848	11200	5·0000
14	·0062	200	·0893	12000	5·3572
15	·0068	300	·1339	13000	5·8036
16	·0071	400	·1786	13440	6·0000
17	·0076	500	·2332	14000	6·2500
18	·0080	600	·2678	15000	6·6964
19	·0084	700	·3125	15680	7·0000
20	·0089	800	·3571	16000	7·1429
30	·0134	900	·4018	17000	7·5893
40	·0178	1000	·4464	17920	8·0000
50	·0233	1120	·5000	18000	8·0357
60	·0268	2000	·8928	19000	8·4822
70	·0312	2240	1·0000	20000	8·9286
				20160	9·0000

METRICAL CONVERSION FACTORS

To convert	Into	Multiply by	Reciprocal
LENGTH			
Inches	Millimetres	25·3999	·03937
Feet	Metres	·30479	3·2809
Yards	Metres	·91438	1·0936
Miles	Kilometres	1·6093	·6214
AREA			
Square inches	Sq. centimetres	6·4514	·1550
Square feet	Square metres	·0929	10·762
Square yards	Square metres	·8360	1·1960
VOLUME			
Cubic inches	Cubic cms.	16·3861	·06102
Cubic feet	Cubic metres	·02831	35·3148
Cubic yards	Cubic metres	·7646	1·3078
Pints	Litres	·56824	1·7598
Gallons	Litres	4·54597	·21998
Cubic feet	Gallons	6·24	·16
Cubic feet	Litres	28·3153	·03532
WEIGHT			
Pounds	Kilogrammes	·45359	2·2046
Tons	Kilogrammes	1016·046	·00098
Tons	Milliers or tonnes	1·01604	·9841
WEIGHT PER FOOT			
Pounds, per ft.	Kils. per metre	1·48819	·67197
PRESSURE, STRESS			
Lb. per sq. in.	Kils. per sq. cm.	·07031	14·223
Lb. per sq. ft.	Kils. per sq. mt.	4·88261	·20482
Tons per sq. in.	Kils. per sq. cm.	157·4877	·00634
Tons per sq. ft.	Kils. per sq. mt.	10937·04	·00009
WORK			
Foot pounds	Kilogr.-metres	·13825	7·233
Foot tons	Kilogr.-metres	309·69051	·00333
Kilowatts	Horse power	1·34	·746
MOMENTS OF INERTIA			
$Inches^3$	$Centimetres^3$	41·6229	·02403
$Inches^4$	$Centimetres^4$	16·38702	·06102

CONVERSION FACTORS

Feet Head of Water	Lb. per sq. in.	·4324	2·3122
B.Th.U.	Therms	·00001	100·000
Therms	Kilowatt hours (B. of T. Units)	29·325	·03410
Kilowatt hours (Board of Trade Units)	B.Th.U.	3410	·0002932
Radians	Degrees	57·3	·01745
Common Logarithms	Natural Logarithms	2·3026	·4343

The standard tables of Conversion Factors in general use are published by the B.S.I as B.S. 350 : 1944 " Conversion Factors and Tables." (3s. 6d.)

LINEAR MEASURE

BRITISH

12 inches	=	1 foot
3 feet	=	1 yard
5½ yards	=	1 pole
22 yards	=	1 chain
40 poles	=	1 furlong
10 chains	=	1 furlong
8 furlongs	=	1 mile
3 miles	=	1 league

METRIC

10 millimetres (mm.)	=	1 centimetre (cm.)
10 centimetres	=	1 decimetre (dcm.)
10 decimetres	=	1 metre (m.)
10 metres	=	1 dekametre (dkm.)
10 dekametres	=	1 hektometre (hkm.)
10 hektometres	=	1 kilometre (km.)
1 toise (Old French)	=	6·39459 feet

SURVEYOR'S LINEAR MEASURE

BRITISH

1 link	=	7·92 inches
25 links	=	1 rod
100 links	=	1 chain
1 chain	=	66 feet
80 chains	=	1 mile
1760 yards	=	1 mile
5280 feet	=	1 mile

SQUARE MEASURE

BRITISH

144 square inches	=	1 square foot
9 square feet	=	1 square yard
30¼ square yards	=	1 rod, pole, or perch
40 square poles	=	1 rood
4 roods	=	1 acre
4840 square yards	=	1 acre
640 acres	=	1 square mile
10 square chains	=	1 acre

METRIC

100 square millimetres	=	1 square centimetre
100 ,, centimetres	=	1 ,, decimetre
100 ,, decimetres	=	1 ,, metre
100 ,, metres	=	1 ,, dekametre
100 ,, dekametres	=	1 ,, hektometre
100 ,, hektometres	=	1 ,, kilometre

CUBIC MEASURE

BRITISH

1728 cubic inches	=	1 cubic foot
27 cubic feet	=	1 cubic yard

AVOIRDUPOIS WEIGHT

BRITISH

27·34 grains	=	1 dram
16 drams	=	1 ounce
16 ounces	=	1 pound
28 pounds	=	1 quarter
4 quarters	=	1 hundredweight
20 hundredweights	=	1 ton
1 ounce (Avoir)	=	437·5 grains
1 ounce (Fluid)	=	1/160th gallon
= 1/20th pint		8 fluid drachms.
1 litre		35·22 fluid ounces
1 gallon	=	4·54597 litres = 160 fluid ounces = 70,000 grains

MEASURES OF CAPACITY—DRY MEASURE

60 minims	=	1 dram
8 drams	=	1 ounce
20 ounces	=	1 pint
2 pints	=	1 quart
4 quarts	=	1 gallon (277·274 cu. in.)
2 gallons	=	1 peck
4 pecks (8 gall.)	=	1 bushel (1·2837 cu. ft.)
1 U.S.A. gallon	=	231 cubic in.

TROY WEIGHT

3·19 grains	=	1 carat
24 grains	=	1 pennyweight (dwt.)
20 pennyweights	=	1 ounce
12 ounces	=	1 pound
100 pounds	=	1 cwt.

CIRCULAR MEASURE

60 seconds (″)	=	1 minute (′)
60 minutes	=	1 degree (°)
90 degrees	=	1 right angle
360 degrees	=	1 circle = 2π radians

A quadrant is one-fourth of a circle.
A sextant is one-sixth of a circle.

NAUTICAL MEASURE

1 Nautical mile	= 6,080 ft. (Admiralty standard).
1 Degree of Longitude at the Equator	= 60 nautical miles (69·09 English miles).
1 Degree of Latitude 89°–90°	= 60·201 nautical miles.
10 Cable Lengths	= 1 nautical mile.
1 Fathom	= 6 ft.
1 Knot (measure of speed)	= 1 nautical mile per hour.
	= 1·1515 English miles per hour.

CUSTOMARY MEASURES

There was at one time considerable variation between one district and another in the methods of measuring land and agricultural produce. These systems are now obsolete, but examples occasionally arise in isolated districts and in ancient legal documents. Few of the present generation have experience in their use and as they are not commonly given in books of architectural reference the more important are set out below.

SCOTTISH LINEAL MEASURE

1 ell			= 37·0598 Imp. in.
6 ells	=	1 fall	= 18·5299 ,, ft.
4 falls	=	1 chain (of 100 links)	= 74·1196 ,, ,,
10 chains	=	1 furlong	= 247·0652 ,, yds.
8 furlongs	=	1 mile	= 1976·5226 ,, ,,
			= 1·123 ,, miles

SCOTTISH SQUARE MEASURE

1 sq. ell	=	9·5377 sq. ft.	= 1·0597 sq. yds.
36 ,, ells	=	1 sq. fall	= 38·1508 ,, ,,
15 ,, falls	=	1 ,, chain	= 610·4128 ,, ,,
40 ,, ,,	=	1 ,, rood	= 1526·03 ,, ,,
4 sq. roods	=	1 acre	= 6104·1 ,, ,,
A Scottish acre			= 1·261 Imp. acres.

Customary measure for land draining, ditching and hedging is now generally based on the *Imperial pole* of 5½ yds. In some areas the *Cheshire rod* of 8 yds. is used. In others, the *Woodland pole* of 6 yds. is used. In Scotland the *fall* is used and in Ireland the *Plantation* pole of 7 yds.

SUNDRY MEASURES—UNUSUAL OR OBSOLETE

In addition to the measures given above, those in the following table may be of use :—

Old Irish Acre	= 7,840 sq. yds.
Old Irish Mile	= 2,240 yds.
Old London Mile	= 5,000 ft.
Old French Measure	= 1 Toise = 3·394 ft.
One Palm	= 3 Imp. ft.
One Hand	= 4 Imp. in.
One Span	= 9 Imp. in.
One Cubit	= 18 Imp. in.
One Cubit (Biblical)	= 21.8 Imp. in.

INDIAN WEIGHTS AND MEASURES

1 Tola	=	Weight of 1 Rupee		
5 Tolas	=	1 Chittack	=	2 2/35 oz.
16 Chittacks	=	1 Seer	=	2 2/35 lb.
40 Seers	=	1 Maund	=	82 2/7 lb.

LAND MEASURE

5 square yards	=	1 Chatack		
16 Chataks	=	1 Cottah		
20 Cottahs	=	1 Bigha	=	1600 sq. yards
3 1/40 Bighas	=	1 Acre		

TEMPERATURE

(F = Fahrenheit : C = Centigrade : R = Reaumur.)

Boiling point of water	= 212°F.	100°C.	80°R.
Freezing point of water	= 32°F.	0°C.	0°R.

BRICKWORK

1 Rod of brickwork = 306 cu. ft. or 11⅓ cu. yds.
= 272 ft. sup. 13½″ brickwork.
= 408 ft. sup. 9″ brickwork.

1 Rod of brickwork contains about 4,360 bricks and weighs about 16 tons. (See also p. 28.)

TIMBER

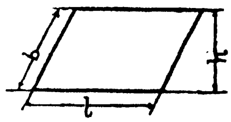
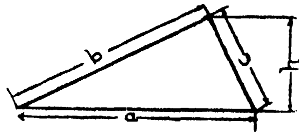
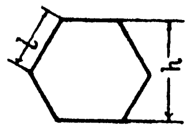
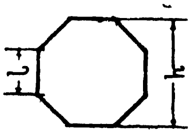
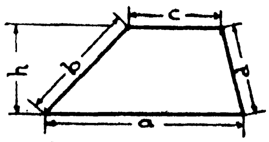
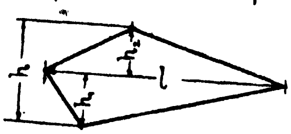
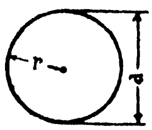
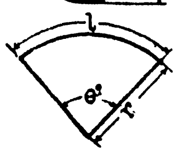
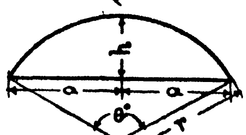
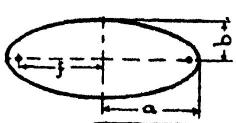
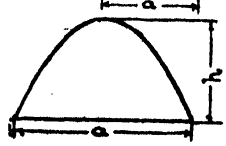
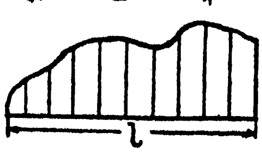
1 Standard = 165 cu. ft.
1 Load (squared) = 50 cu. ft.

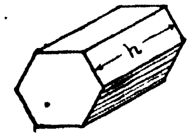
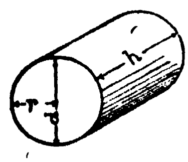
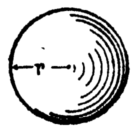
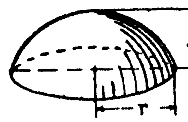
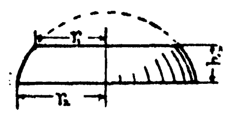
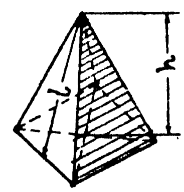
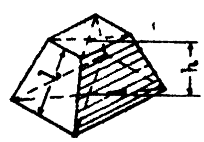
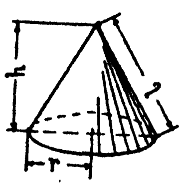
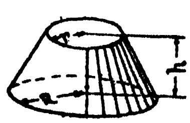
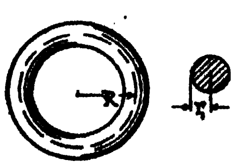
To find feet run of any sized timber in 1 Standard :

$$L = \frac{144 \times 165}{A} \text{ feet run}$$

where A = cross-sectional area of scantling in sq. in. (See also p. 30.)

MATHEMATICAL DATA

Title	*Figure*	*Circumference or Perimeter*	*Area*
PARALLELOGRAM		$2(l + b)$	$l \times h$
TRIANGLE		$a + b + c$	$\frac{ah}{2}$ or $\frac{1}{2}ab \sin C$ or $\sqrt{s(s-a)(s-b)(s-c)}$ where $s = \frac{1}{2}(a + b + c)$
HEXAGON		$6l$ or $3{\cdot}46h$	$2\ 6l^2$ or $\cdot866h^2$
OCTAGON		$8l$ or $3{\cdot}32h$	$4{\cdot}83l^2$ or $\cdot829h^2$
TRAPEZOID		$a + b + c + d$	$h\left(\frac{a + c}{2}\right)$
IRREGULAR QUADRILATERAL OR TRAPEZIUM		Sum of sides	Divide into two triangles by either diagonal, find area of each triangle and add, or area $= \frac{lh}{2}$ where $h = h_1 + h_2$
CIRCLE		πd or $2\pi r$	$\frac{\pi}{4}d^2 = \cdot7854d^2$ or $\pi r^2 = 3{\cdot}1416r^2$
SECTOR OF A CIRCLE		$2r + l$ where $l = \frac{r\theta^\circ}{57{\cdot}3}$	$\frac{\pi\theta^\circ r^2}{360}$ where θ in degrees
SEGMENT OF A CIRCLE		$r = \frac{a^2 + h^2}{2h}$ where $a = \sqrt{2hr-h^2}$	$\frac{\pi r^2\theta^\circ}{360} - a(r - h)$
ELLIPSE *Note:* See p. 86 for construction.		$\pi\left\{1{\cdot}5(a + b) - \sqrt{ab}\right\}$	πab
PARABOLA		Length of Arc $= 2\sqrt{\frac{a^2}{4} + \frac{4}{3}h^2}$	$\frac{2}{3}ah$
IRREGULAR FIGURES		With dividers step round curved portion in small steps: add in any straight pieces.	$l\left(\frac{\text{Sum of lengths of all ordinates}}{\text{Total number of ordinates}}\right)$

Title	*Figure*	*Volume*	*Surface Area*
ANY PRISM		Area of base × h	Perimeter of base × h + 2(area of ends)
CYLINDER		$\pi r^2 h$ or $\cdot 7854 d^2 h$	Curved surface $2\pi rh$ Total area = $2\pi r(h + r)$
SPHERE		$\frac{4}{3}\pi r^3$	$4\pi r^2$
SEGMENT OF SPHERE		$\frac{\pi}{6}h(h^2 + 3r^2)$ or	Curved surface = $\pi(r^2 + h^2)$
ZONE OF SPHERE		$\frac{\pi h}{6}\left(h^2 + 3r_1^2 + 3r_2^2\right)$	Curved surface = $2\pi Rh$ where R = radius of original sphere
ANY PYRAMID		$\frac{1}{3}$ area of base × h	$\frac{1}{2}$ perimeter of base × h : plus area of base
FRUSTUM OF ANY PYRAMID		" A " = area of large end " B " = area of small end Volume = $\frac{h}{3}\left(A + B + \sqrt{AB}\right)$	Lateral area = $\frac{1}{2}$ mean perimeter × l
CONE		$\frac{1}{3}\pi r^2 h$	$\pi r\,(l + r)$
FRUSTUM OF CONE		$\frac{\pi h}{3}\left(R^2 + r^2 + Rr\right)$	Curved surface $\pi l(R + r)$ where l = slant height
ANCHOR RING		$2\pi^2 R r_1^2$	$4\pi^2 R r_1$

CIRCLES

AREAS OF CIRCLES ADVANCING BY EIGHTHS

Diameter	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
0		·012	·049	·110	·196	·307	·442	·601
1	·785	·994	1·227	1·485	1·767	2·074	2·405	2·761
2	3·142	3·547	3·976	4·430	4·909	5·412	5·940	6·492
3	7·069	7·670	8·296	8·946	9·621	10·321	11·045	11·793
4	12·566	13·364	14·186	15·033	15·904	16·800	17·721	18·665
5	19·635	20·629	21·648	22·691	23·758	24·850	25·967	27·109
6	28·274	29·465	30·680	31·919	33·183	34·472	35·785	37·122
7	38·485	39·871	41·282	42·718	44·179	45·664	47·173	48·707
8	50·265	51·849	53·456	55·088	56·745	58·426	60·132	61·862
9	63·617	65·397	67·201	69·029	70·882	72·760	74·662	76·589
10	78·540	80·516	82·516	84·541	86·590	88·664	90·763	92·886
11	95·033	97·205	99·402	101·62	103·87	106·14	108·43	110·75
12	113·10	115·47	117·86	120·28	122·72	125·19	127·68	130·19
13	132·73	135·30	137·89	140·50	143·14	145·80	148·49	151·20
14	153·94	156·70	159·48	162·30	165·13	167·99	170·87	173·78
15	176·71	179·67	182·65	185·66	188·69	191·75	194·83	197·93
16	201·06	204·22	207·39	210·60	213·82	217·08	220·35	223·65
17	226·98	230·33	233·71	238·10	240·53	243·98	247·45	250·95
18	254·47	258·02	261·59	265·18	268·80	272·45	276·12	279·81
19	283·53	287·27	291·04	294·83	298·65	302·49	306·35	310·24
20	314·16	318·10	322·06	326·05	330·06	334·10	338·16	342·25
21	346·36	350·50	354·66	358·84	363·05	367·28	371·54	375·83
22	380·13	384·46	388·82	393·20	397·61	402·04	406·49	410·97
23	415·48	420·00	424·56	429·13	433·74	438·36	443·01	447·69
24	452·39	457·11	461·86	466·64	471·44	476·26	481·11	485·98
25	490·87	495·79	500·74	505·71	510·71	515·72	520·77	525·84
26	530·93	536·05	541·19	546·35	551·55	556·76	562·00	567·27
27	572·56	577·87	583·21	588·57	593·96	599·37	604·81	610·27
28	615·75	621·26	626·80	632·36	637·94	643·55	464·18	654·84
29	660·52	666·23	671·96	677·71	683·49	689·30	695·13	700·98
30	706·86	712·76	718·69	724·64	730·62	736·62	742·64	748·69
31	754·77	760·87	766·99	773·14	779·31	785·51	791·73	797·98
32	804·25	810·54	816·86	823·21	829·58	835·97	842·39	848·83
33	855·30	861·79	868·31	874·85	881·41	888·00	894·62	901·26
34	907·92	914·61	921·32	928·06	934·82	941·61	948·42	955·25
35	962·11	969·00	975·91	982·84	989·80	996·78	1003·8	1010·8
36	1017·9	1025·0	1032·1	1039·2	1046·3	1053·5	1060·7	1068·0
37	1075·2	1082·5	1089·8	1097·1	1104·5	1111·8	1119·2	1126·7
38	1134·1	1141·6	1149·1	1156·6	1164·2	1171·7	1179·3	1186·9
39	1194·6	1202·3	1210·0	1217·7	1225·4	1233·2	1241·0	1248·8
40	1256·6	1264·5	1272·4	1280·3	1288·2	1296·2	1304·2	1312·2
41	1320·3	1328·3	1336·4	1344·5	1352·7	1360·8	1369·0	1377·2
42	1385·4	1393·7	1402·0	1410·3	1418·6	1427·0	1435·4	1443·8
43	1452·2	1460·7	1469·1	1477·6	1486·2	1494·7	1503·3	1511·9
44	1520·5	1529·2	1537·9	1546·6	1555·3	1564·0	1572·8	1581·6
45	1590·4	1599·3	1608·2	1617·0	1626·0	1634·9	1643·9	1652·9
46	1661·9	1670·9	1680·0	1689·1	1698·2	1707·4	1716·5	1725·7
47	1734·9	1744·2	1753·5	1762·7	1772·1	1781·4	1790·8	1800·1
48	1809·6	1819·0	1828·5	1837·9	1847·5	1857·0	1866·5	1876·1
49	1885·7	1895·4	1905·0	1914·7	1924·4	1934·2	1943·9	1953·7
50	1963·5	1973·3	1983·2	1993·1	2003·0	2012·9	2022·8	2032·8
51	2042·8	2052·8	2062·9	2073·0	2083·1	2093·2	2103·3	2113·5
52	2123·7	2133·9	2144·2	2154·5	2164·8	2175·1	2185·4	2195·8
53	2206·2	2216·6	2227·0	2237·5	2248·0	2258·5	2269·1	2279·6
54	2290·2	2300·8	2311·5	2322·1	2332·8	2343·5	2354·3	2365·0
55	2375·8	2386·6	2397·5	2408·3	2419·2	2430·1	2441·1	2452·0
56	2463·0	2474·0	2485·0	2496·1	2507·2	2518·3	2529·4	2540·6
57	2551·8	2563·0	2574·2	2585·4	2596·7	2608·0	2619·4	2630·7
58	2642·1	2653·5	2664·9	2676·4	2687·8	2699·3	2710·9	2722·4
59	2734·0	2745·6	2757·2	2768·8	2780·5	2792·2	2803·9	2815·7
60	2827·4	2839·2	2851·0	2862·9	2874·8	2886·6	2898·6	2910·5
61	2922·5	2934·5	2945·5	2958·5	2970·6	2982·7	2994·8	3006·9
62	3019·1	3031·3	3043·5	3055·7	3068·0	3080·3	3092·6	3104·9
63	3117·2	3129·6	3142·0	3154·5	3166·9	3179·4	3191·9	3204·4
64	3217·0	3229·6	3242·2	3254·8	3267·5	3280·1	3292·8	3305·6
65	3318·3	3331·1	3343·9	3356·7	3369·6	3382·4	3395·3	3408·2
66	3421·2	3434·2	3447·2	3460·2	3473·2	3486·3	3499·4	3512·5
67	3525·7	3538·8	3552·0	3565·2	3578·5	3591·7	3605·0	3618·3
68	3631·7	3645·0	3658·4	3671·8	3685·3	3698·7	3712·2	3725·7
69	3739·3	3752·8	3766·4	3780·0	3793·7	3807·3	3821·0	3834·7
70	3848·5	3862·2	3876·0	3889·8	3903·6	3917·5	3931·4	3945·3
71	3959·2	3973·1	3987·1	4001·1	4015·2	4029·2	4043·3	4057·4
72	4071·5	4085·7	4099·8	4114·0	4128·2	4142·5	4156·8	4171·1
73	4185·4	4199·7	4214·1	4228·5	4242·9	4257·4	4271·8	4286·3
74	4300·8	4315·4	4329·9	4344·5	4359·2	4373·8	4388·5	4403·2
75	4417·9	4432·6	444h·4	4462·2	4477·0	4491·8	4506·7	4521·5
76	4536·5	4551·4	5466·4	4581·3	4596·3	4611·4	4626·4	4641·5
77	4656·6	4671·8	4686·9	4702·1	4717·3	4732·5	4747·8	4763·1
78	4778·4	4793·7	4809·0	4824·4	4839·8	4855·2	4870·7	4886·2
79	4901·7	4917·2	4932·7	4948·3	4963·9	4979·5	4995·2	5010·9
80	5026·5	5042·3	5058·0	5073·8	5089·6	5105·4	5121·2	5137·1
81	5153·0	5168·9	5184·9	5200·8	5216·8	5232·8	5248·9	5264·9
82	5281·0	5297·1	5313·3	5329·4	5345·6	5361·8	5378·1	5394·3
83	5410·6	5426·9	5443·3	5459·6	5476·0	5492·4	5508·8	5525·3
84	5541·8	5558·3	5574·8	5591·4	5607·9	5624·5	5641·2	5657·8
85	5674·5	5691·2	5707·9	5724·7	5741·5	5758·3	5775·1	5791·9
86	5808·8	5825·7	5842·6	5895·6	5876·5	5893·5	5910·6	5927·6
87	5944·7	5961·8	5978·9	5996·0	6013·2	6030·4	6047·6	6064·9
88	6082·1	6099·4	6116·7	6134·1	6151·4	6168·8	6186·2	6203·7
89	6221·1	6238·6	6256·1	6273·7	6291·2	6308·8	6326·4	6344·1
90	6361·7	6379·4	6397·1	6414·9	6432·6	6450·4	6468·2	6486·0
91	6503·9	6521·8	6539·7	6557·6	6575·5	6593·5	6611·5	6629·6
92	6647·6	6665·7	6683·8	6701·9	6720·1	6738·2	6756·4	6774·7
93	6792·9	6811·2	6829·5	6847·8	6866·1	6884·5	6902·9	6921·3
94	6939·8	6958·2	6976·7	6995·3	7013·8	7032·4	7051·0	7069·6
95	7088·2	7106·9	7125·6	7144·3	7163·0	7181·8	7200·6	7219·4
96	7238·2	7257·1	7276·0	7294·9	7313·8	7332·8	7351·8	7370·8
97	7389·8	7408·9	7428·0	7447·1	7466·2	7485·3	7504·5	7523·7
98	7543·0	7562·2	7581·5	7600·8	7620·1	7639·5	7658·9	7678·3
99	7697·7	7717·1	7736·6	7756·1	7775·6	7795·2	7814·8	7834·4
100	7854·0	7873·6	7893·3	7913·0	7932·7	7952·5	7972·2	7992·0

CIRCUMFERENCES OF CIRCLES ADVANCING BY EIGHTHS

Diameter	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
0		·393	·785	1·178	1·571	1·963	2·356	2·749
1	3·142	3·534	3·927	4·320	4·712	5·105	5·498	5·890
2	6·283	6·676	7·069	7·461	7·854	8·247	8·639	9·032
3	9·425	9·817	10·210	10·603	10·996	11·388	11·781	12·174
4	12·566	12·959	13·352	13·744	14·137	14·530	14·923	15·315
5	15·708	16·101	16·493	16·886	17·279	17·671	18·064	18·457
6	18·850	19·242	19·635	20·028	20·420	20·813	21·206	21·598
7	21·991	22·384	22·777	23·169	23·562	23·955	24·347	24·740
8	25·133	25·525	25·918	26·311	26·704	27·096	27·489	27·882
9	28·274	28·667	29·060	29·452	29·845	30·238	30·631	31·023
10	31·416	31·809	32·201	32·594	32·987	33·379	33·772	34·165
11	34·558	34·950	35·343	35·736	36·128	36·521	36·914	37·306
12	37·699	38·092	38·485	38·877	39·270	39·663	40·055	40·448
13	40·841	41·233	41·626	42·019	42·412	42·804	43·197	43·590
14	43·982	44·375	44·768	45·160	45·553	45·946	46·338	46·731
15	47·124	47·517	47·909	48·302	48·695	49·087	49·480	49·873
16	50·265	60·658	51·051	51·444	51·836	52·229	52·622	53·014
17	53·407	53·800	54·192	545·85	54·978	55·371	55·763	56·156
18	56·549	56·941	57·334	57·727	58·119	58·512	58·905	59·298
19	59·690	60·083	60·476	60·868	61·261	61·654	62·046	62·439
20	62·832	63·225	63·617	64·010	64·403	64·795	65·188	65·581
21	65·973	66·366	66·759	67·152	67·544	67·937	68·330	68·722
22	69·115	69·508	69·900	70·293	70·686	71·079	71·471	71·864
23	72·257	72·649	73·042	73·435	73·827	74·220	74·613	75·006
24	75·398	75·791	76·184	76·576	76·969	77·362	77·754	78·147
25	78·540	78·933	79·325	79·718	80·111	80·503	80·896	81·289
26	81·681	82·074	82·467	82·860	83·252	83·645	84·038	84·430
27	84·823	85·216	85·608	86·001	86·394	86·786	87·179	87·572
28	87·965	88·357	88·750	89·143	89·535	89·928	90·321	90·713
29	91·106	91·499	91·892	92·284	92·677	93·070	93·462	93·855
30	94·248	94·640	95·033	95·426	95·819	92·211	96·604	96·997
31	97·389	97·782	98·175	98·567	98·960	99·353	99·746	100·14
32	100·53	100·92	101·32	101·71	102·10	102·49	102·89	103·28
33	103·67	104·07	104·46	104·85	105·24	105·64	106·03	106·42
34	106·81	107·21	107·60	107·99	108·38	108·78	109·17	109·56
35	109·96	110·35	110·74	111·13	111·53	111·92	112·31	112·70
36	113·10	113·49	113·88	114·28	114·67	115·06	115·45	115·85
37	116·24	116·63	117·02	117·42	117·81	118·20	118·60	118·99
38	119·38	119·77	120·17	120·56	120·95	121·34	121·74	122·13
39	122·52	122·91	123·31	123·70	124·09	124·49	124·88	125·27
40	125·66	126·06	126·45	126·84	127·23	127·63	128·02	128·41
41	128·81	129·20	129·59	129·98	130·38	130·77	131·16	131·55
42	131·95	132·34	132·73	133·12	133·52	133·91	134·30	134·70
43	135·09	135·48	135·87	136·27	136·66	137·05	137·44	137·84
44	138·23	138·62	139·02	139·41	139·80	140·19	140·59	140·98
45	141·37	141·76	142·16	142·55	142·94	143·34	143·73	144·12
46	144·51	144·91	145·30	145·69	146·08	146·48	145·87	147·26
47	147·65	148·05	148·44	148·83	149·23	149·62	150·01	150·40
48	150·80	151·19	151·58	151·97	152·37	152·76	153·15	153·55
49	153·94	154·33	154·72	155·12	155·51	155·90	156·29	156·69
50	157·08	157·47	157·86	158·26	158·65	159·04	159·44	159·83
51	160·22	160·61	161·01	161·40	161·79	162·18	162·58	162·97
52	163·36	163·76	164·15	164·54	164·93	165·33	165·72	166·11
53	166·50	166·90	167·29	167·68	163·08	168·47	168·86	169·25
54	169·65	170·04	170·43	170·82	171·22	171·61	172·00	172·39
55	172·79	173·18	173·57	173·97	174·36	174·75	175·14	175·54
56	175·93	176·32	176·71	177·11	177·50	177·89	178·29	178·68
57	179·07	179·46	179·86	180·25	180·64	181·03	181·43	181·82
58	182·21	182·61	183·00	183·39	183·78	184·18	184·57	184·96
59	185·35	185·75	186·14	186·53	186·92	187·32	187·71	188·10
60	188·50	188·89	189·28	189·67	190·07	190·46	190·85	191·24
61	191·64	192·03	192·42	192·82	193·21	193·60	193·99	194·39
62	194·78	195·17	195·56	195·96	196·35	195·74	197·13	197·53
63	197·92	198·31	198·71	199·10	199·49	199·88	200·28	200·67
64	201·06	201·45	201·85	202·24	202·63	203·03	203·42	203·81
65	204·20	204·60	204·99	205·38	205·77	206·17	206·56	206·95
66	207·35	207·74	208·13	208·52	208·92	209·31	209·70	210·09
67	210·49	210·88	211·27	211·66	212·05	212·45	212·84	213·24
68	213·63	214·02	214·41	214·81	215·20	215·59	215·98	216·38
69	216·77	217·16	217·56	217·95	218·34	218·73	219·13	219·52
70	219·91	220·30	220·70	221·09	221·48	221·87	222·27	222·66
71	223·05	223·45	223·84	224·23	224·62	225·02	225·41	225·80
72	226·19	226·59	226·98	227·37	227·77	228·16	228·55	228·94
73	229·34	229·73	230·12	230·51	230·91	231·30	231·69	232·09
74	232·48	232·87	233·26	233·66	234·05	234·44	234·83	235·23
75	235·62	236·01	236·40	236·80	237·19	237·58	237·98	238·37
76	238·76	239·15	239·55	239·94	240·33	240·72	241·12	241·51
77	241·90	242·30	242·69	243·08	243·47	243·87	244·26	244·65
78	245·04	245·44	245·83	246·22	246·62	247·01	247·40	247·79
79	248·19	248·58	248·97	249·36	249·76	250·15	250·54	250·93
80	251·33	251·72	252·11	252·51	252·90	253·29	253·68	254·08
81	254·47	254·86	255·25	255·65	256·04	256·43	256·83	257·22
82	257·61	258·00	258·40	258·79	259·18	259·57	259·97	260·36
83	260·75	261·14	261·54	261·93	262·32	262·72	263·11	263·50
84	263·89	264·29	264·68	265·07	265·46	265·86	266·25	266·64
85	267·04	267·43	267·82	268·21	268·61	269·00	269·39	269·78
86	270·18	270·57	270·96	271·36	271·75	272·14	272·53	272·93
87	273·32	273·71	274·10	274·50	274·89	275·28	275·67	276·07
88	276·46	276·85	277·25	277·64	278·03	278·42	278·82	279·21
89	279·60	279·99	280·39	280·78	281·17	281·57	281·96	282·35
90	282·74	283·14	283·53	283·92	284·31	284·71	285·10	285·49
91	285·88	286·28	286·67	287·06	287·46	287·85	288·24	288·63
92	289·03	289·42	289·81	290·20	290·60	290·99	291·38	291·78
93	292·17	292·56	292·95	293·35	293·74	294·13	294·52	294·92
94	295·31	295·70	296·10	296·49	296·88	297·27	297·67	298·06
95	298·45	298·84	299·24	299·63	300·02	300·41	300·81	301·20
96	301·59	301·99	302·38	302·77	303·16	303·16	303·95	304·34
97	304·73	305·13	305·52	305·91	306·31	306·70	307·09	307·48
98	307·88	308·27	308·66	309·05	309·45	309·84	310·23	310·62
99	311·02	311·41	311·80	312·20	312·59	312·98	313·37	313·77
100	314·16	314·55	314·94	315·34	315·73	316·12	316·52	316·91

CASKS

Sizes and capacities of casks vary according to the kind of liquor content, but the following table gives some typical sizes :—

Name of Cask	Capacity in Gallons	Extreme Bung diameter		Extreme length measured along stave (ft.)	Weight when empty (lb.)
		In.	Ft.		
Ledger	170	38·5	3·20	4·52	252
Butt	108	33·3	2·77	3·97	174
Puncheon ...	72	30·7	2·55	3·20	140
Hogshead	54	28·6	2·38	2·76	119
Barrel	36	25·3	2·10	2·42	88
Half Hogshead ...	27	22·7	1·90	2·12	65
Kilderkin	18	20·3	1·70	1·81	49
Small cask (oct.) ...	14	18·3	1·52	1·76	32
Firkin	9	17·0	1·41	1·37	20
Small cask... ...	6	13·8	1·15	—	—
Pin	4½	13·3	1·11	—	—

SIZES AND CAPACITIES OF WINE, SPIRITS AND BEER BOTTLES

All British wine and spirit bottles of standard size contain one-sixth of a gallon (26 2/3 fluid ozs.), i.e., 6 bottles to one gallon.

1 Imperial gallon contains 160 fluid ozs. = 277·274 cu. in.
1 Imperial gallon contains 4½ litres.
1 Litre contains 35·2 fluid ozs.

Kind	Capacity	Diameter (in.)	Height (in)
	fluid ozs.		
Beer and Stout	½ pint : 10	2¼	9
„ „	1 pint : 20	2⅝	10¾
	1 quart : 40	3¾	12½
Whisky, Rum, Port, Gin	— : 26⅔	3	12
Brandy	— : 25	3	12
Cherry Brandy (Herrings)	— : 25½	—	11½
Peach Bitters, etc. ...	— : —	up to 3	up to 15
Vermouth (French) ...	1 litre : 35·22	up to 3⅜	12¾
„ (Italian) ...	„ „	„ „	up to 12½
Hock	— : —	2¾	up to 14
Benedictine	— : 26⅔	4¼	10¾
Cointreau	— : 26	4	8¾
Creme de Menthe ...	— : 25½	—	11
Chartreuse	— : 35	—	12⅞
Grand Marnier	— : 25¼	4¼	8¾
Kirsch	— : —	—	14½
Kummel (Allash)	— : 21⅓	—	11¾
Square Gin	— : 26⅔	—	9¾
Soda Syphon	— : —	3¼	12
Small Soda bottles ...	— : —	2 3/16	7 3/16
Ginger beer	— : —	2⅝	7¾

Note.—The above heights do not include for projecting corks or stoppers.

MATS AND MAT SINKINGS

The door mat sinking or well should be finished 1¾″ deep, and ½″ should be added to each dimension of the stock sizes of coco-fibre door mats given below. It is desirable to finish the well with a metal rim. If the edge has a special section of a flat ogee at the ends, it facilitates the sweeping out of the well. The stock sizes of coco-fibre mats are as follows :—

Length in Inches 24, 27, 30, 33, 36, 39, 42, 45, 48.
Width in Inches 14, 16, 18, 20, 22, 24, 26, 28, 30.

A raised threshold is sometimes preferred to a mat-sinking, being more easily kept clean.

METAL WORK, DECORATIVE

See special article "Aluminium—Its Architectural Uses," page 200.

See Post-War Building Studies, No. 13, "Non-Ferrous metals."

EXTRUDED METAL

In this process a non-ferrous metal is heated and then forced or extruded, by pressure through a die. There is practically no limit to the shape of section which can be produced : fine arrises are possible, and as metal used in architectural metal-work is seldom less than ⅛″ to 3/16″ thick, it is generally unnecessary to provide a wooden core.

DRAWN METAL

In this process the cold metal sheet or strip is drawn through one of a series of dies by tension. The metal is generally thinner than that used in extruded metal process, and is, therefore, usually mounted on a wooden core. A wider range of metals can be worked by this process than by the extrusion method.

ROLLED METAL

The rolling is done with either hot or cold metal in a similar manner to that used in the production of steel joist sections. The finished metal section is usually heavier than drawn work.

ELECTRO-PLATING

This term is used to describe the deposit of any metal or metal alloys by means of electric currents. The coatings obtained vary in protective power, life and decorative value according to the metal deposited and the conditions, atmosphere, wear, etc. In specifying electro-plated work every case must be considered on its merits, and it is essential that the work be done by a reputable firm. Where the work is of any magnitude a chemist or metallurgist should be consulted.

The more important metals deposited electrolytically as coatings for decorative or protective purposes are:—Silver, Gold, Nickel, Chromium, Copper, Tin, Zinc and Cadmium. Zinc and Cadmium are used particularly for the protection of iron and steel from corrosion. (See "Rust Prevention," p. 122).

CHROMIUM PLATING

Before chromium-plating any material it should be highly polished and free from scratches or other surface blemishes. Chromium should never be deposited on brass unless a heavy coat of nickel is interposed. In the case of iron, a thick coat of copper should be applied first, then one of nickel, and finally the chromium.

GALVANISING, ETC.

(See "Rust Prevention," p. 122.)

STAINLESS METALS

Resistance to corrosion or tarnishing are of great importance in metals used for architectural decorative purposes. In the case of metals which, on grounds of cost or difficulty in fabrication, are not in themselves structural materials, their corrosion-resisting properties can in some cases be utilised by electro-deposition. Of the structural materials which are themselves resistant to attack, the following are the most important :—

Aluminium

Though readily attacked by some corroding media, it is highly resistant to certain types of atomspheric corrosion, particularly in indoor atmospheres. This is due to the protective action of a thin oxide film which forms naturally on the metal surface. The artificial production of a thicker film by "anodic oxidation" increases the corrosion resistance considerably, but results in the formation of a matt surface.

Nickel

Pure nickel is itself highly resistant to atmospheric oxidation. Except in the case of electrolytic coatings it is usually employed as nickel rich alloys, of which Silveroid and Monel Metal are two important examples.

Silveroid

This is an alloy containing 55 per cent nickel and 45 per cent copper which can be worked readily in the hot or cold states. The appearance is very similar to that of pure nickel, and the bright surface is maintained for long periods—particularly in indoor atmospheres.

Monel Metal

This is a corrosion-resisting alloy of approximately 67 per cent nickel, 28 per cent copper and 5 per cent other metals, similar in appearance to pure nickel. It can be machined, solid drawn, forged, cast, soldered, brazed and welded. The hot rolled metal has a breaking tensile strength of from 30 to 42 tons per sq. in. according to treatment. It is used in the engineering trades where a strong corrosion-resisting metal is required, and also in the food manufacturing, catering and shop-fitting trades.

Pewter

Old pewter is a rich alloy of tin and lead with some silver, originally used for pots, dishes and spoons and public-house bar fittings. Modern English pewter, which has been developed in recent years, is a harder alloy of tin with small additions of other metals—from which lead is excluded. This material has a high resistance to corrosion.

Stainless Steel

This metal owes its property to the presence of a sufficient proportion of chromium, the general resistance of a steel increasing with the chromium content. Steel which solidifies at 1,000°C. is known as Austenite, and is the most important kind for architectural metalwork. In this state the steel is unstable and undergoes certain changes in cooling. By the addition of nickel (about 8 per cent) and chromium (about 14 per cent) the stability of the Austenite is retained at normal temperatures, and the metal thus produced has similar properties to those of normal steel, with the addition of being non-corrosive. Staybrite, Anka, Silver-Fox and V.2A. are varieties of this metal, which can be obtained with either a dull or brightly polished surface.

References :

P.W.B.S. No. 13, "Non-Ferrous Metals" (H.M.S.O.), 1944, 1s. 0d. "Aluminium in Architecture" (Aluminium Union, Ltd.) "Nickel-Silver in Architecture" (Mond Nickel Co., Ltd.), 1940. See also under "Copper," "Roofing" and "Plumbing" and "Zinc."

SOLDERS—Analyses of British Standard Soft Solders to pre-war British Standard are as follows :—

(The Standard at present in force is B.S. 219 : 1942, a war-emergency issue. Soft solders are restricted to five grades, the main purpose being economy in the use of tin.)

1	2	3	4	5	6		7	8	9	10
		Tin %		Antimony %			Impurities			
B.S. Grade	Use for which the Solder is primarily intended	Min.	Max.	Min.	Max.	Lead	Aluminium or Zinc %	Iron % Max.	Arsenic % Max.	Total Max.
A	Work requiring low melting point : Steel tube joints	64·0	66·0	—	1·0		0	0·02	0·05	0·25
B	Tinsmiths' and Coppersmiths' fine work and bit soldering generally ...	49·0	51·0	2·50	3·00		0	0·02	0·05	0·25
C	General Work	39·0	41·0	2·0	2·40		0	0·02	0·05	0·25
D	Plumbers' Wiped joints ...	29·0	31·0	1·00	1·70		0	0·02	0·05	0·25
E	Special Electrical Purposes ...	94·5	95·5	—	0·50	The Remainder	0	—	—	0·25.
F	General Electrical Purposes : Zinc and galvanised ironwork	49·0	51·0	—	0·50		0	0·02	0·05	0·25
G	Dipping Baths : Zinc and galvanised ironwork : Tinned electrical joints ...	41·0	43·0	—	0·40		0	0·02	0·05	0·25
H	Lead cable wiped joints ...	34·0	36·0	—	0·30		0	0·02	0·05	0·25
	Dipping Baths	29·0	31·0	—	0·30		0	0·02	0·05	0·25

BRONZES AND BRASSES

Name	Copper per cent	Tin per cent	Zinc per cent	Various per cent
Admiralty Bronze	88	10	2	
Phosphor Bronze for bearings, etc.	85–95	5–14		Phosphorous 0·1–1·0
Bell metal	75–85	remainder		
Statuary Bronze ...	90–95	2–10	0–5	Lead 0–5
Bronze for stopcocks and valves	85	5	5	Lead 5
Gilding metals ...	80–95		remainder	
" Cartridge Brass " for cold working ...	70		30	
65–35 brass for cold pressing, etc. ...	65		35	
Muntz metal or " yellow metal " ...	60		40	
High-tensile brass or " Maganese Bronze "	58		38	Manganese Tin, Aluminium, Iron Nickel 4
Aluminium Bronze	90–95			Aluminium 5–10
Delta Metal ...	55·5	0·25	41·5	1 Lead 1 Iron ¾ Manganese

Note.—The terms " Bronze " and " Brass " are unfortunately used somewhat loosely, but, strictly speaking, a Bronze is primarily a copper tin alloy' and a Brass a copper zinc alloy.

COLOURS OF BRASSES (COPPER-ZINC ALLOYS)

As the copper content in copper-zinc alloys is reduced, the warm reddish colour of copper is gradually changed, and the gilding metals containing 95 per cent down to 80 per cent copper have, as their name implies, a range of golden colours, grading to yellow. These are used for various decorative purposes such as for shop-fronts, etc., where, when treated to yield a rich brown colour, they are frequently misnamed " bronze."

TIN, ANTIMONY AND LEAD ALLOYS

Name	Copper per cent	Tin per cent	Lead per cent	Antimony per cent	Various per cent
Tin-base white metal bearing alloys ...	0·10	80–96		6–20	
Britannia metal ...	1	85–90		7–10	0–3 Zinc
Type metal		2–20	50–88	10–30	
Stereotype metal ...		3–10	83–73	14–70	
Common Pewter ...		80	20		
Plate Pewter ...	1·8	88–89		7·1	1·8 Bismuth

NICKEL ALLOYS

Name	Copper per cent	Zinc per cent	Nickel per cent	Various per cent
Common German Silver	60	25	15	1 Iron
Silveroid	55	—	44	1 Various
Monel Metal	28	—	67	5 Various

METEOROLOGICAL DATA

The following table has been prepared from the Meteorological Office publication entitled " The Book of Normals of Meteorological Elements for the British Isles," with a view to showing the average and extreme temperatures and rainfalls likely to be met with in certain representative districts in Great Britain. It is thought that they may be of value in calculating heating installations, and also in connection with the utilization of rain-water for domestic or industrial purposes. Complete combined tables for Normals during more recent years do not appear to have been published. However, it may be said with some safety that where the figures have been averaged over comparatively long periods (as for instance from 1881 to 1915) there is very little likelihood that an average struck over a similar period would be substantially different as a forecast.

Station	Mean Annual Rainfall		Snowfall Mean No. of days per year on which snow fell	Temperature					Frost	
	mm.	in.		Normal for Year °F.	Highest for Year °F	Highest for Year Date	Lowest for Year °F	Lowest for Year Date	Mean No. days with Ground Frost per Year	Period of Observation
Orkney	901	35·4	30·8	45·3	76	16/7/76	8	18/1/81	*	*
Aberdeen ... ... Balmoral	748	29·4	34·0	46·3	86	16/7/76	4	18/1/81	151·5	1908–20
Glasgow	945	37·2	16·5	47·3	85	12/7/11	7	10/2/95	78·8	1911–20
North Shields ... ... Rounton	621	24·4	22·6	47·2	88	1/9/06	6	27/1/81	* 132·2	1908–20
Yarmouth ... ... Cambridge	622	24·4	16·7	48·4	89	22/8/18	10	16/1/81	* 111·9	* 1908–20
Oxford	631	24·8	16·8	49·2	95	9/8/11	6	25/12/78	91·4	1909–20
Greenwich ... ... Kew	596	23·4	* 13·4	50·1	100	10/8/11	4	8/1/81	100·8	1908–20
Southampton ... ... Portsmouth	786	23·4	*	50·8	92	15/7/81	11	3/3/09	* 61·0	* 1908–20
Falmouth	1107	30·9	5·2	50·9	83	18/7/21	20	5/1/94	48·3	1914–20
Dublin	695	43·5	18·3	50·0	87	16/7/76	13	15/12/82	35·5	1908–20
Ben Nevis	4084	160	169·6	31·5	66	28/6/02	1	6/1/94	*	—
Buxton (Derby) ...	1231	44·6	37·8	45·4	89	16/7/76	–11	11/2/95	110·6	1908–20
Southport (Lancashire)	813	32·0	9·8	48·4	89	24/8/84	2	16/1/81	82·6	1908–20
Holyhead (Anglesey) ...	888	35·0	7·0	49·5	86	14/2/14	17	8/2/95	*	—

Notes.—Mean Anual Rainfall based mainly on the years 1881–1915.
Snowfall based on years 1881–1915. No account is taken of the amount of snow that falls.
Ground Frost is said to have occurred when the grass minimum thermometer falls to 30°F. or lower.
* No records available.

NEW BUILDING

OPERATIONS DEEMED TO BE THE ERECTION OF BUILDINGS

Section 90 of the Public Health Act, 1936, provides that each of the following operations shall, for certain purposes of the Act and to the extent that byelaws made thereunder may provide, for the purposes of those byelaws, be deemed to be the erection of a new building :—

(i) The re-erection of any building or part of a building of which an outer wall is pulled down or burnt down to, or within 10′ of, the surface of the ground adjoining the lowest storey of the building or part.

(ii) The re-erection of any frame building or part of a frame building when that building or part has been so far pulled down, or burnt down as to leave only the framework of the lowest storey of the building or part.

(iii) The roofing or covering over of an open space between walls or buildings. (See also Byelaw No. 2, Model Byelaws (Series IV), Buildings 1938.

NEW STREETS AND BUILDINGS OUTSIDE THE LONDON AREA

MEMORANDUM ON PLANS FOR HOUSES AND OTHER BUILDINGS

(No. C.34 of the Ministry of Health.)

I. INTRODUCTORY

(A) The powers and duties of local authorities with regard to the control of building are everywhere both limited and definite, but they are not the same in all districts. Any person who does not understand, or who wishes to question, the action of a local authority on plans which he has formally deposited with them should, if he has not been given the information, *ask them* under what statutory or other powers they are acting.

(B) In any communication to a Government Department about the action of a local authority, it is important to give the name of the authority, i.e., the borough, or the urban or rural district (and, in a rural district, the parish), and to forward any notice or other document received from the local authority.

(C) This memorandum should be read through : paragraphs taken from their context may be misleading. In any case, it gives only an *outline* of certain provisions of the law. Persons who wish to know their legal rights or liabilities in particular circumstances are warned that no memorandum of this kind can cover every case, or take the place of the advice of a solicitor with all the facts before him. Any appeal to the Courts has usually to be made within a limited time, so that it is advisable for a person who contemplates an appeal to consult a solicitor as soon as possible.

2. LOCAL ACTS OF PARLIAMENT

In the County of London, building is largely controlled by local Acts of Parliament or by other provisions differing from the ordinary law. Further, some provincial local authorities have local Acts of Parliament which may add to or vary the ordinary law with regard to buildings or streets. Local Acts of Parliament passed in the present century usually add to the general law, rather than alter it, but some of the older local acts contain complete codes of building law differing from that in force in the country at large. The requirements of these Acts are often much more rigid than those of the general law and of byelaws, and the terms of the particular local Act, where one exists, must always be ascertained. A copy of any provisions in a local Act relating to any matter about which building byelaws may be made under the ordinary law must be appended to the printed copies of any building byelaws in force.

3. BUILDING BYELAWS

(A) *General.*—Most local authorities have made building byelaws under the Public Health Act, 1936. Any person has the right to inspect the local byelaws at the local authority's offices, at all reasonable hours, without payment, and to be furnished with a copy on payment of a charge not exceeding one shilling.

(B) *New Buildings.*—Byelaws always require a person who intends to erect a building to which they relate to deposit plans and other particulars (usually in duplicate) with the local authority. As a rule, they only require that the plans shall show exactly what is proposed, but there may be local variations about the scale, etc. The plans should be accurately and intelligibly drawn or reproduced on suitable and durable material, but there is seldom a requirement that they shall be on any particular material, and it is never compulsory to have them drawn by an architect. As indicated in paragraph 12, a deposit of plans in connexion with building byelaws will often serve as an application for permission under the Town and Country Planning Acts, but for this purpose the plans must be *in triplicate*.

Section 64 of the Public Health Act, 1936, requires the local authority to give written notice of the passing or rejection of plans within one month or, when the byelaws so provide, within five weeks of the deposit of the plans with them. Passing of plans under this section operates only for the purposes of the byelaws and of those sections of the Act which expressly require or authorize rejection of plans in certain cases, as explained in paragraph 4 below. A notice of rejection must indicate why the plans have not been passed (i.e., specify the defects in the plans, or the byelaw or section of the Act to which they do not conform) together with any right of appeal.

Needless delay in obtaining the passing of plans can be avoided by noting that a local authority must either pass plans or reject them : they cannot, for instance, pass plans on condition that the work is carried out in a modified form, so as to comply with a byelaw which the plans contravene. There should, therefore, be careful reference to the byelaws before, during, and after, the preparation of plans and before they are deposited with the local authority, to ensure as far as possible not only that they conform to the byelaws as to deposit of plans, but that the work shown on them will conform to the byelaws applicable to it.

Wherever a byelaw requiring the deposit of plans of any work is in force, it is a separate offence (for which the local authority can prosecute) to proceed with the work without depositing plans drawn in accordance with the byelaws, even though the work itself complies with the byelaws. A person is not compelled to wait for the passing of his plans before beginning work shown on them, but it is most desirable to find out whether the local authority see any legal obstacle to the proposal before work is begun.

The remedy if a local authority does not pass plans is not in the Minister's hands. If plans complying with the law are rejected, the following are the normal courses open to the person submitting the plans :—

1. **He can, *before the proposed work has been substantially commenced*, apply to the Justices to determine any**

question arising between the local authority and himself as to whether the plans are defective, or the proposed work would contravene any of the building byelaws (section 64 (3) of the Act).

2. He and the local authority can *jointly* refer the question in dispute to the Minister of Health—see paragraph 9.
3. He can erect the building, and defend himself if proceedings are taken against him.

Section 64 (5) of the Act provides that a local authority may, if the byelaws require plans, etc., to be deposited in duplicate, retain one copy, whether or not the plans are passed, and a few local authorities also have provisions in local Acts relating to the retention of plans.

The general law does not authorize a local authority or its officials to receive any fee for the examination of plans deposited under the requirements of the byelaws or for the inspection of any work, or for the testing of drains or sewers.

(C) *Structural Alterations and Extensions.*—Byelaws usually apply to structural alterations and extensions of buildings and to buildings so far as affected thereby. What is said above about plans of new buildings applies also to plans of such alterations and extensions.

(D) *Material Change of Use.*—Where there is a material change of use, as defined in section 62 (2) of the Act, e.g., the use as a house of a building which is not already being so used, byelaws usually require that notice shall be given to the local authority, whether or not it is intended to execute any work in connexion with the change. What is said above about plans relates also to any alterations made in connexion with a change of use.

(E) *Works and Fittings.*—Byelaws usually require a person who executes drainage works in connexion with any building to deposit plans with the local authority. A person who executes other works or instals fittings, e.g., who constructs a watercloset, urinal, earth closet, ashpit, or cesspool, or a well or water-tank ; or who fits a cistern, stove, gas fire or geyser, is usually required to give notice to the local authority and to comply with whatever byelaws are applicable to the work, but not to deposit plans unless the work is in connexion with the erection, structural alteration, or extension of a building.

4. PROVISIONS OF THE PUBLIC HEALTH ACT, 1936, REQUIRING OR AUTHORIZING REJECTION OF PLANS

Paragraph 3 (B) above refers to provisions of the Public Health Act, 1936, which sometimes require or authorize the rejection of plans deposited in accordance with building byelaws. These sections are explained below. There are certain rights of appeal to the Justices to determine questions arising out of decisions of the local authority under these sections ; these rights must be indicated on the notice of the decision of the local authority. The time limit for appeal is twenty-one days from the service of the notice. There is a further appeal from the decision of the Justices to Quarter Sessions.

(A) *Impregnated Sites.*—Section 54 provides that where the site on which it is proposed to erect a building or an extension of a building is ground which has been filled up with any material impregnated with faecal or offensive animal or vegetable matter, or is ground upon which any such material has been deposited, the local authority shall reject the plans, unless they are satisfied that the material has been removed, or has become or been rendered innocuous.

(B) *Building Over Sewer or Drain.*—Section 25 requires the local authority to reject the plans of a building or of an extension of a building proposed to be erected over a sewer or drain which is shown on their map of sewers, unless they are satisfied that in the circumstances they may properly consent to the erection of the building or extension, with or without conditions.

(C) *Drainage.*—Section 37 requires the local authority to reject the plans of a building or of an extension of a building, unless either the plans show that satisfactory provision will be made for the drainage of the building or extension, or they are satisfied that in the circumstances they may properly dispense with any provision for drainage.

(D) *Closet Accommodation.*—Section 43 requires the local authority to reject the plans of a building or of an extension of a building unless either the plans show that sufficient and satisfactory closet accommodation will be provided, or they are satisfied that in the circumstances they may properly dispense with closet accommodation.

(E) *Water Supply.*—Section 137 as amended by Section 29 of the Water Act, 1945, requires the local authority to reject the plans of a *house* unless there is put before them a proposal which appears to them to be satisfactory for providing the occupants of the house with a supply of wholesome water sufficient for their domestic purposes :—

(*a*) By connecting the house to a piped supply provided by the local authority or other statutory water undertakers ; or

(*b*) If this is not reasonable by otherwise taking water into the house by means of a pipe ; or

(*c*) If neither of the above alternatives can reasonably be required, by providing a supply of water within a reasonable distance of the house ;

and the authority are satisfied that the proposal can and will be carried into effect.

If the local authority find that the proposals for providing a supply of water to a house have not been carried into effect or have not yielded the necessary supply, they must give the owner written notice prohibiting occupation until they grant him a certificate that they are satisfied that the supply has been provided. The service of the notice makes it unlawful for the owner to occupy the house or permit it to be occupied until this certificate has been granted.

(F) *Means of Access to House for Disposal of Refuse, etc.*—Section 55 provides that the local authority shall reject the plans for the erection or extension of a *house* unless it is shown to them that satisfactory means of access from the house to a street for the removal of refuse and faecal matter can and will be provided. It is unlawful to close or obstruct the means of access for this purpose except with the consent of the local authority.

(G) *Buildings Constructed of Short-Lived Materials.*—Section 53 provides that where the plans show that it is proposed to construct or to place or assemble on the site a building of materials *specified in the byelaws* as liable (in the absence of special care) to rapid deterioration, or as otherwise unsuitable for the construction of permanent buildings, the local authority may, although the plans comply with the byelaws :—

(i) Reject the plans ; or

(ii) In passing the plans fix a period at the end of which the building must be removed, and impose on the use of the building any reasonable conditions that they deem appropriate in view of the nature of the materials used in its construction. No condition conflicting with any provision applicable to the building under a planning scheme may be imposed.

If a building, plans of which should have been deposited but have not, appears to the local authority to be constructed of such specified materials, the local authority may, without prejudice to their right to take proceedings for any contravention of the byelaws, fix a period after which it must be removed and impose conditions on its use. If they do so, they must give written notice to the owner.

A local authority may from time to time extend any period fixed and, when granting any extension, or upon application to them by the owner of the building, may vary any condition imposed under this section.

When a period fixed under this section expires the owner must remove the building, and if he fails to do so the local authority are required by the Act to remove it and may recover from him the expenses reasonably incurred in doing so. The owner is also liable to a fine for his failure to remove the building.

A person who uses a building in contravention of any condition imposed under this section, or who permits it to be so used, is also liable to penalties.

This section applies to extensions of existing buildings as well as to new buildings.

5. ENFORCEMENT OF BUILDING BYELAWS, ETC.

(A) Local authorities have three methods of enforcing their building byelaws and the provisions of the Public Health Act, 1936, requiring the rejection of plans.

(i) As already mentioned, they may take legal proceedings before the Justices for a fine. These proceedings must be taken within six months of the offence.

(ii) Without prejudice to (i) they may give written notice under section 65 of the Act, requiring the owner of a building or work which contravenes the byelaws to pull down or remove the work, or to bring it into conformity with them. The owner can appeal to the Justices, but if he neither appeals successfully nor complies with the notice, the local authority may carry out the requirements of the notice at his expense. To be effective, the notice must be given within twelve months of the completion of the work.

(iii) They may, through the Attorney General, apply to the High Court for an injunction, requiring the removal or alteration of the work. This can be done at any time.

(B) A person aggrieved by work contravening the building byelaws, or any other person who has the written consent of the Attorney General, may also take legal proceedings against the person carrying out the work.

6. HABITATION CERTIFICATES

In a few local Acts there is a requirement that a certificate that a new dwelling-house is fit for human habitation must be obtained from the local authority's surveyor, before it is let or occupied, *but the number of districts where these certificates must be obtained before a building can legally be let or occupied is very small.*

Even in districts where it is not compulsory, a purchaser or mortgagee of the property may sometimes ask for such a certificate, and some local authorities are willing to grant one in similar terms (usually to the effect that the house has been inspected, and, maybe, that they found no reason to question the legality of the work). *Unless, however, there is a local Act making it compulsory to obtain a certificate, there is no obligation to do so,* nor on the local authority or their officials to give one, and the Minister of Health has for many years advised local authorities not to give certificates. (But see (E) of paragraph 4 above, relating to water supply.)

7. BYELAWS RELATING TO NEW STREETS

Byelaws relating to the level, width and construction of new streets are in force in many districts. What is said in paragraphs 3 and 5 above about building byelaws applies in general to these byelaws also, but they are made under the Public Health Act, 1875 (as extended by later Acts), and not under the Public Health Act, 1936, so that references to the latter are inappropriate to these byelaws. In reading paragraph 3 (B) it must be borne in mind that section 158 of the Act of 1875 requires that notice of approval or disapproval of plans of new streets must be given in writing by the local authority *within one month* of the delivery of the plans to them, and that section 16 of the Public Health Acts Amendment Act, 1907 (where in force) empowers a local authority to retain only approved plans of new streets, even if the plans have to be deposited in duplicate.

The definition of " street " in section 4 of the Act of 1875 is very wide. The questions, what constitute the laying out and the construction of a new street, are difficult, and have given rise to many cases in the Courts. The Minister has no power to decide these questions (but see paragraph 9 below). A person who proposes to erect a building is not necessarily required to construct, or even to lay out, a new street, or to provide other means of access, except for the disposal of refuse ; but if he does lay out or construct a new street he must comply with the appropriate byelaws as to its level, width and construction. Moreover, by section 30 of the Public Health Act, 1925, where it appears to a local authority or, in a rural district, to the County Council (under section 30 of the Local Government Act, 1929) that the whole or any portion of an existing *highway* (the word is important) will be converted into a new street as a consequence of building operations, the local authority or (in a rural district) the County Council may make an order declaring it to be a new street. Public notice must be given of the order for at least one month, and an appeal against its making can be made to Quarter Sessions. There is no right of appeal to the Minister. Once the order is in force a person who builds beside the highway is deemed to be laying out a new street and byelaws relating to the width of new streets will apply accordingly.

8. WAIVER OF BYELAWS AND LOCAL ACTS

(A) Section 63 of the Public Health Act, 1936, provides that, where a local authority consider that the operation of any *building* byelaw in force in their district would be unreasonable in relation to any particular case, they may with the Minister's consent relax the requirements of the byelaw or dispense with compliance therewith. The local authority must give public notice of the proposal as the Minister directs. The Minister must consider any objection he receives, and may not give his consent until the expiry of a month from the giving of the notice. This power does not apply to byelaws relating to new streets, but local authorities can prevent an unreasonable application of these by formally amending them. There is no legal difficulty about an amendment limited to particular proposals, if a case for this is made out and the case for a general amendment is not.

(B) Under section 138 of the Housing Act, 1936, byelaws and *local* Acts (relating both to buildings and to new streets) can be overriden in certain circumstances by operations under the Housing Acts. In a district where such housing operations have involved departures from the byelaws or local Acts, other housing operations involving departures *from the same byelaws or local Acts, and to the same extent* may be carried out. Local authorities have no discretionary power over such departures, but they may (obviously)

dispute a claim that a contravention is in fact to the same extent only as that which has occurred in operations under the Housing Acts. On this question of fact there is an appeal to the Minister.

(C) There may be relaxations of byelaws relating to new streets under planning powers.

9. AGREED REFERENCES

Section 67 of the Public Health Act, 1936, provides that if any question arises between a local authority and a person who has executed, or proposes to execute, any work :—

- (*a*) As to the application to that work of any building byelaws ; or
- (*b*) Whether the plans of the work are in conformity with those byelaws ; or
- (*c*) Whether the work has been executed in accordance with the plans as passed by the authority ;

the question may, on a *joint* application of the parties, be referred to the Minister, whose decision shall be final.

The Minister will consider requests for his opinion on similar questions, e.g., arising out of the byelaws relating to new streets, *if both parties wish for it.*

A separate memorandum upon the procedure to be followed in referring questions to the Minister will be sent on request. But persons aggrieved by the proposals of, or work carried out by, other persons should note that this procedure is not available for settlement of disputes of that kind.

10. ACTS OF PARLIAMENT GENERALLY BUILDING LINES AND IMPROVEMENT LINES

There are some other provisions with which a new building may have to comply. The most important of these are the Restriction of Ribbon Development Act, and the Town Planning Acts, outlines of which are given below, but the following should also be noted.

(A) *The Public Health (Buildings in Streets) Act*, 1888.—This Act forbids the erection or bringing forward, without the consent of the local authority, of any building or part of a building beyond the front main wall of the building on either side in the same street. It is important to note that :—

- (*a*) The word " building " in this Act has been held by the Courts to have a wider meaning than it ordinarily has ;
- (*b*) The Act does not apply at all unless the proposed new building is in a street ;
- (*c*) There must be " some degree of proximity " between the existing building or buildings and the new building ;
- (*d*) The line is fixed by the existing building or buildings and the local authority cannot prescribe it for themselves. A person from whom consent is withheld has a right of appeal to Quarter Sessions. This Act is in force in every urban district but not usually in rural districts.

(B) The Roads Improvement Act, 1925, enables any County Council or other highway authority (which includes the Minister of Transport in relation to trunk roads) to prescribe a building line in any highway maintainable by them. Where such a building line is in force, it is unlawful to build in front of the line without the consent (which may be subject to conditions) of the authority who prescribed it, and under this Act if the consent is refused there is no right of appeal. There is provision for compensation to persons whose property is affected provided application is made within a limited time after the line has been prescribed.

(C) *Improvement Lines.*—Sections 33 and 34 of the Public Health Act, 1925, enable a local authority, in relation to any street repairable by them (and the Minister of Transport in relation to trunk roads) to prescribe an improvement line, i.e., the line to which a street or road is sooner or later to be widened. There is provision for compensation to persons whose property is affected. Where an improvement line has been prescribed under this Act, it is unlawful to build in front of the line without the consent of the authority, and this may be for a period only, and subject to conditions. There is a right of appeal to Quarter Sessions, both against the prescribing of a line, and against a refusal of consent to build.

The provisions mentioned in (A), (B) and (C) above have two points in common :—

- (i) *There is no right of appeal to the Minister of Health.*
- (ii) Any rights of appeal are confined to persons whose property is directly affected ; they are not available to other persons, e.g., neighbours, who may be aggrieved by a decision to permit the erection or alteration of a building.

11. RESTRICTION OF RIBBON DEVELOPMENT

(A) Section 1 of the Restriction of Ribbon Development Act, 1935, provides that, where the County Council or other authority for the purposes of the Act have adopted a standard width of a road and the Minister of Transport has given his approval, it is unlawful without the consent of that authority to form any means of access to or from the road or to erect any building or make any permanent excavation or execute any other works nearer to the middle of the road than a distance equal to one-half of the standard width adopted.

(B) Section 2 of the Act makes it unlawful, without the consent of the authority for the purposes of the Act, to form any means of access to or from, or to build (except for agricultural purposes) within two hundred and twenty feet of the middle of a road which is subject to the restrictions of the Act.

(C) The " middle of the road " means the point half-way between the boundaries of the road, except where plans for the improvement of the road have been approved by the Minister of Transport, when it means the middle of the road as improved in accordance with the plans.

(D) Authorities for the purposes of the Act are County Councils and Town Councils or Urban District Councils by whom the functions of road maintenance and repair are exercisable or would be exercisable but for the Trunk Roads Act, 1936. The Minister of Transport is the highway authority for trunk roads, but the functions of sections 1 and 2 of the Act of 1935 are still exercised by the Councils mentioned. These authorities are required to keep available for inspection by the public at all reasonable times, free of charge, sufficient plans showing all roads which are subject to restrictions under these provisions, the nature of the restrictions, and the area of land to which the restrictions apply.

(E) " Building " is defined in the Act as including any part of a building, and all structures and erections except (*a*) temporary tents or scaffolding required for any purpose, (*b*) fences, gates, posts, masts, etc., required for the purposes of agriculture or of any dwelling-house or garden occupied with a dwelling-house, (*c*) greenhouses or summerhouses required in connexion with such a garden. Control under the Act applies also to certain changes in the use of a building,

e.g., conversion into a dwelling-house of any building not originally constructed for human habitation, the extension of a building, and the re-erection of a building if an outer wall has been pulled half-way down, otherwise than in consequence of fire or other accident.

Appeal against refusal of consent, or conditions attached to a consent, may be made to the Minister of Transport. Except as otherwise agreed in writing between the authority and the applicant, consent is deemed to have been given unconditionally if the authority have not given written notification of their decision within *two* months, or where a trunk road is concerned, and the authority are required to consult the Minister of Transport, within *three* months. In the latter case, the authority are required to notify the applicant of the position within fourteen days.

A person who executes any work in contravention of these restrictions is liable to a heavy fine, and the work may be removed at his expense. The Restriction of Ribbon Development (Temporary Development) Act, 1943, empowers the authority to postpone enforcement, where immediate enforcement appears to them inexpedient in the public interest. There is provision for compensation to an owner affected by restrictions under the Act, but compensation is not payable until he can prove that his property is injuriously affected by the restrictions.

12. TOWN AND COUNTRY PLANNING

The main body of law on town and country planning is contained in the Town and Country Planning Act, 1932, but by subsequent legislation " the Minister " under the Act is now the Minister of Town and Country Planning, not the Minister of Health. Important amendments to the Act have been made by the Town and Country Planning (Interim Development) Act, 1943, and the Town and Country Planning Act, 1944.

Development is defined for planning purposes in section 53 of the Act of 1932. It includes any building or rebuilding operation, or any use of the land or any building thereon for a purpose different from that for which the land or building was last being used, except where the new use of the land, as distinct from the erection of buildings on the land, is for agriculture or, being within the curtilage of a dwelling-house, is incidental to the enjoyment of the dwelling-house as such.

A person who proposes to undertake development should ascertain whether a planning scheme is operative ; if so, all the development in the area which it covers has to comply with it. Where there is not a planning scheme, all land is now subject to interim development control and is governed by the Town and Country Planning Acts, 1932 and 1943, and the Town and Country Planning (Interim Development) Order, 1946. Development not of a type permitted by the Order cannot safely be carried out without permission of the interim development authority (who are usually, but not always, the local authority for byelaw purposes) ; since, under section 5 of the Act of 1943, the interim development authority may remove or pull down any building or work or part thereof and reinstate any land which has been developed without their permission, if it is contrary to the proposals for the future scheme. The Act does not make it unlawful to carry out development without this permission, but if any development is so carried out it may be removed and/or the land may be reinstated *at once and without compensation.*

The only safe way to avoid the risk of contravening the Acts is to consult the Local Land Charges Register and to submit any necessary application to the responsible authority in the case of an operative scheme, or, where no operative scheme is in force, apply to the interim development authority for consent to the desired development. The Local Land Charges Register* will show who are the responsible authority for the operative scheme and where the scheme and map may be consulted or, alternatively, who are the interim development authority.

An application for permission to develop must be made in writing and be accompanied by a plan in triplicate, sufficient to identify the land to which the application relates, and by particulars illustrated by plans and drawings *in triplicate* sufficient to indicate the proposed development. Where the interim development authority are also the authority with whom plans of streets or buildings must be deposited under any byelaws or local Acts, or whose approval is required under enactments relating to statutory undertakers, one application (provided that it is accompanied by the necessary plans and drawings *in triplicate*) is sufficient.

The decision of an interim development authority on an application must be in writing and, if the application is refused or is granted subject to conditions the interim development authority are required to give the reasons. An application is deemed to be refused unless within two months of the date of its receipt by the interim development authority notice has been given :—

(i) That the authority have decided :—

- (*a*) To grant permission with or without conditions ;
- (*b*) To refuse consent ; or
- (*c*) To postpone consideration on the ground that the development cannot be carried out immediately ;

or

(ii) That the application has, in accordance with a direction of the Minister of Town and Country Planning, been referred to him.

Where an application has been refused or granted subject to conditions by the interim development authority, there is a right of appeal to the Minister of Town and Country Planning. The appeal must be made within 28 days of the receipt of the notice from the interim development authority of their decision (or such longer period as may have been allowed by the Minister) or of the expiry of the period at the end of which the application is deemed to have been refused. A form of appeal may be obtained on application to the Ministry of Town and Country Planning.

A person who has received notice of the postponement of consideration of this application can appeal to the Justices for cancellation of the notice on the ground that development would be carried out immediately if the application were granted. Such an appeal must be made within 28 days of the service of the notice of postponement.

This brief statement of the position gives only a general indication of what the Acts and the Order provide, and the terms of the Acts and Order (or in the case of an operative scheme, the scheme itself) should be carefully studied. It is most imprudent to develop land without ascertaining, if need be with the aid of private legal advice, the provisions relating to town and country planning.

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* This may be consulted also for ascertaining whether the restrictions mentioned in paragraphs 10(B), 10(C) and 11, apply.

OFFENSIVE TRADES

Section 107 of the Public Health Act, 1936, sets out a list of offensive trades and empowers local authorities to add to the list, subject to confirmation by the Minister of Health. By section 108 they may make byelaws for the regulation of such trades. It is an offence to establish any new business in one of the listed trades without consent of the local authority, but refusal of consent is subject to appeal to a Court of Summary Jurisdiction.

ORDNANCE SURVEY MAPS

(For complete description see "A Description of Ordnance Small Scale Maps," and "A Description of Large Scale Maps," price 1s. 0d. each, published by Edward Stanford, Ltd., Whitehall House, 30, Charing Cross, London, S.W.1.)

HISTORICAL MAPS

The edition of the Ordnance Map of Roman Britain gives a representation of Britain during the Roman occupation. The area of the map extends to the limits of the Roman penetration of Scotland and is produced to the scale of 15·782 miles to 1″ (1/100,000). A map of seventeenth century England is published to the same scale as that of Roman Britain.

DATUM LEVELS

The altitudes printed on the older plans of Great Britain show heights above an assumed mean sea level at Liverpool which was approximately ascertained in 1844 after only a fortnight's observations. Later observations proved that this datum was ·65′ (about 8″) below true mean sea level. The altitudes on Ordnance Survey Maps, being levels based on the Liverpool Datum, may, therefore, be taken as starting from a point ·65′ below the mean sea level as thus calculated.

THE NEWLYN DATUM

Since the original primary levelling of Great Britain was carried out, instruments and methods have greatly advanced, and an entirely new levelling of sufficient accuracy to meet all modern requirements has been undertaken. Newlyn was selected as a suitable place to fix a datum, and the Newlyn Datum is the mean sea level computed from hourly observations over a period of six years. The difference between the old and new levels is shown to the nearest ·1 of a ft. on all 1/2500 and 6″ Ordnance Maps prepared after April, 1929. A diagram showing the general differences is published, and on this diagram + and — indicate that altitudes in relation to the Newlyn Datum are greater or less respectively than those which refer to the Liverpool Datum.

For islands at a distance from the mainland, the levels are based on independent datums computed from local observations for mean sea level.

STANDARD MEASURES OF LENGTH

Imperial standard measures of length have been laid down at the places given in the list below, and are used to check surveying chains, tapes, rods, etc.

In London the standards of length were placed in 1876, along the base of the north wall enclosing Trafalgar Square, and consist of :—

1. A standard measure of 100′ sub-divided at intervals of 1′ up to 10′, and then at intervals of 10′.
   At the 100′ marking, a fixed brass plate gives the division of 1′ in inches and tenths of inches.
2. A standard chain of 100 links (66′) sub-divided at intervals of 10 links.
3. A standard pole or perch.
4. End measures of :—
   (*a*) 1′.
   (*b*) 2′.
   (*c*) 1 yd.

When testing measures of 66′ or 100′ a tension must be applied (usually by means of a spring balance). The amounts prescribed for trade measures are 2 lb. for ordinary tapes, 10 lb. for metal tapes, and 15 lb. for linked measures taken at 62° F.

Mural standards of various denominations can be found in the following places :—

Birmingham	Chamberlain Square
Bradford	Victoria Square
Dublin	National Gallery
Glasgow	City Hall
Greenwich	Observatory
Liverpool	Walker Art Gallery
London	Guildhall and Trafalgar Square
Manchester	Assize Courts
Reading (Berkshire County Council)	Assize Courts
Sheffield	St. Paul's Parade
South Kensington (London)	Science Museum

THE STANDARD MAP

The original standard map of the Ordnance Survey is the 1″ to 1 mile. It covers the whole country and shows altitudes above mean sea level along the main roads and summits of high ground, and also contours at 50′ intervals.

LARGE SCALE MAPS

These include maps to the scale of :—

(*a*) 1 : 10,560 or 6″ to 1 mile.

These maps cover the whole of the United Kingdom. The original size of each sheet was 36″ × 24″—Full Sheets—but now all revised sheets are issued in Quarter Sheet size (18″ × 12″).

(*b*) 1 : 2,500 or 25·344″ to 1 mile.

These maps cover the cultivated districts only of Great Britain. Waste and mountainous regions are not published to this scale. Each sheet measures 38″ × 25$\frac{1}{3}$″ and contains an area of 1$\frac{1}{2}$ square miles (960 acres). The chief difference between the 6″ and the 25″ maps is that the latter give the areas of all enclosures, whereas the former do not.

A large number of 1/2500 scale plans covering portions of cities and towns in Great Britain have been enlarged by photography to the scale of 1/1250 (104·166′ to 1 mile). Each enlargement covers one quarter of a 1/2500 scale plan (240 acres) and measures about 38″ × 25$\frac{1}{3}$″. Enlargements not already published can be specially prepared on application.

(*c*) 1 : 1,056 or 60″ to 1 mile (London only).

The plans of London and Environs specially revised for Land Registry purposes to the scale of 1/1056 (60″ to 1 mile) are obtainable.

MAPS FOR TOWN AND COUNTRY PLANNING SCHEMES

The maps used for submitting Town and Country Planning Schemes are 25″ to 1 mile, unless the permission of the Minister of Town and Country Planning is obtained to use a smaller scale. Advisory regional planning schemes are usually submitted on either of the following maps :—

(1) 6″ to 1 mile, reduced to 3″ to 1 mile.

(2) 1″ to 1 mile, enlarged to 2″ to 1 mile.

THE NATIONAL GRID

An overprint in the form of grid-lines numbered on a national scheme is now added to O.S. maps, enabling any point to be defined by a four figure reference to the nearest 10 metres or by a six-figure reference to the nearest metre, when using the large-scale maps, with a lesser degree of precision on the small and medium maps.

Full details of the system appear in O.S. Booklet No. 1/45 issued by the Director-General, O.S., Chessington, Surrey.

NUMBERING

The 6″ sheets in each county or group of counties are numbered consecutively in Roman Figures. The Quarter Sheets are distinguished by the letters N.W., N.E., S.W., S.E., according to their position in the Full Six-inch Sheet (See diagram). The 1/2500 sheets falling within a 6″ sheet area are numbered consecutively from 1 to 16. In the diagram the Roman figures XXXIII denote the number of the 6″ full sheet; the letters N.W., N.E., S.W., S.E., the 6″ quarter sheets; the smaller rectangles numbered from 1 to 16 the sheet lines and numbers of the 25″ maps falling within the area covered by the 6″ sheet. The maps to the scale of 1–1250 are numbered on the same principle. Four of the former fill the space occupied by one 25″ plan, and these are distinguished by the letters N.W., N.E., S.W., and S.E.

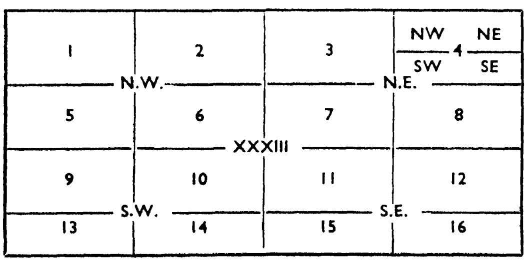
ORDERING MAPS

To order a 6″ map it is necessary to quote (1) the County in which the area is, (2) the 6″ sheet number, and (3) the letters denoting the particular quarter sheet required: thus, Dorset XXXIII, S.E.

For 25″ maps it is necessary to quote (1) the County (2) the 6″ sheet number, and (3) the number indicating the position of the 25″ plan within the 6″ sheet: thus, Dorset XXXIII, 12.

For 1/1250 maps it is necessary to quote (1) the County, (2) the full number of the 25″ map within which the 1/1250 map falls, and (3) the letters indicating its position on that plan: thus, Dorset XXXIII, 4, N.W.

The scale of the maps required should always be stated.



INDEXES AND CATALOGUES

Index diagrams showing the incidence of 6″ and 25″ Sheets of England and Wales are published by the Ordnance Survey. The diagrams consist of detailed maps to the scale of four miles to 1″, and each sheet shows a complete County with the 6″ and 25″ sheet lines and county boundaries printed in red. Similar indexes are published for Scotland.

WHERE MAPS MAY BE OBTAINED

All maps may be obtained from principal booksellers, stationers and railway bookstalls throughout Great Britain. Orders may be sent direct to :—(1) Director-General Ordnance Survey, Southampton. (2) Publication Sales Offices of H.M. Stationery Office. For London, agents are:—Edward Stanford, Ltd., 12, Long Acre, W.C.2, and Sifton Praed and Co., Ltd., 67, St. James's Street, S.W.1.

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ORGANS

Organs in cinemas and theatres require two chambers, one for the solo department and one for the accompaniment department. Each of these chambers—for a medium size three-manual organ—should be approximately 15′ wide × 8′ deep × 10′ 6″ high; and for larger organs approximately 18′ 6″ wide × 10′ 6″ deep × 11′ high. These dimensions do not apply to churches, concert halls, etc.

The position of the organ chambers must be considered in relation to the acoustical form of the building and the type of organ installed. The following positions are suggested as reasonable alternatives for consideration :—

(1) Divided: one on each side of the proscenium.

This position is usually unsatisfactory in the case of a small organ, unless the building is narrow and the sound openings can be placed close to the screen; for unless great care is taken the solo parts will appear to be separated from the accompaniment; but for large organs it is quite satisfactory, provided the distance between the chambers is not too great.

(2) Over the proscenium.

This is a good situation provided the sound duct is short and the sound opening not too high to prevent the more delicate tones reaching under the circle or gallery.

(3) Under the stage.

This is a good position where the shape of the theatre is short and wide. The sound will appear to come from the screen; but care must be taken to ensure that the sound openings are adequate in area and height, to avoid "bottling" the organ. The console in such cases should not be placed in the full stream of sound, as the organist will be apt to misjudge the volume.

(4) Both chambers on one side of the proscenium.

This is generally the most satisfactory position, provided the grille is kept at a moderate height to allow the sound to travel under the circle or gallery easily, without being of such volume as to disturb the audience in the front of the circle. Chambers in this position should be arranged one above the other, allowing the use of a long narrow grille. Extra space will be required for the blowing unit in addition to the organ chambers, and this should be not less than 7′ × 4′ × 6′ high to allow access to all machinery. The position of the blowing unit relative to the chambers is not important, so long as it does not necessitate a longer run of trunking than 100′. This trunking is between 9″ and 12″ in diameter: it is made of zinc and should be protected where exposed to possible damage.

The electric relay action is usually placed in the chambers, and does not require separation.

The console may be placed in any suitable position and may be provided with a lift to allow the organist to be in or out of sight of the audience.

The swell shutters are fitted into the opening from the chamber to the theatre, and are operated from the console by electro-pneumatic action. The area varies from 65 sq. ft. upwards, the height being from 6′ 6″ to 7′.

Organ chambers should have the corners rounded off and the surfaces rendered with some hard finish : the floor should be of concrete, with wood surface to provide easy fixing of parts.

The advice of the organ builder should be sought at the earliest stage of planning, in order to avoid placing the chambers in unsuitable positions.

OVERHANGING LAMPS, SIGNS, ETC.

LONDON COUNTY COUNCIL BYELAWS

(See L.B. Act. Byelaws made on 30th June, 1914, under section 164 of the London Building Act, 1894.)

Lamps.—No lamp overhanging the public way shall (1) be at a less height than 8′ clear above the surface of the footway immediately beneath, (2) be nearer the carriage-way than 2′ 6″ from the outer edge of kerb, or (3) project more than 5′ from the wall or shop front of the premises or post or upright support to which it is attached. These byelaws do not apply to the re-erection of any such lamp which has been fixed before the date of confirmation of these byelaws, if the interval between removal and re-fixing does not exceed 6 months ; but notice must be given.

No lamp overhanging the public way shall exceed (including framework and ornaments) 3′ in any part measured horizontally, or 5′ in height, or 84 lb. in weight. Any lamp which may be lawfully fixed shall be provided with a secondary means of security of sufficient strength to sustain the whole weight of the lamp from falling away from its support.

Signs.—No sign overhanging the public way shall (1) be in any part either of the sign or its supports at a less height than 8′ clear above the surface of the footway immediately below or (2) nearer to the carriage way than 2′ 6″ from the outer-edge of the kerb or (3) project more than 4′ from the wall or shop front of the premises or upright support to which it is attached. Where such a sign or structure extends more than 2′ (not including stays or supports) along the face of the wall, shop front or support, it shall not project more than 2′.

No overhanging sign shall exceed 2′ 6″ in height or 6′ in any direction (not including stays or supports) along the face of the wall or shop front of the premises, or upright support.

Dispensations.—The L.C.C. has the power, after consultation with the local authority, to dispense with the observance of any of the foregoing byelaws as it may think proper.

Note.—Permanent and continuous canopies have been permitted to shops in the London area, but special application for permission to erect must be made.

Exemptions.—These byelaws do not apply to :—

1. Any fascia, balcony, shelter, covered way or other projection overhanging the public way (not being a lamp or sign or other structure within the meaning of these byelaws) which has been or shall be duly sanctioned by the L.C.C. under the Local Byelaw Acts or other Statute.
2. Any overhanging sun-blind, no part of which, or of the staybars or other fittings of which, except valances or side blinds, shall when open be below an imaginary straight line drawn from a point 7′ above the footway at a distance of 2′ from the outer edge of the kerb to a point 7′ 6″ above the footway adjoining the front of the shop or premises, and which shall not be nearer to the carriageway than 1′ 6″ from the outer edge of the kerb, or any valance or side blind which does not project more than 2′ from the front of the shop below the level of 7′ 6″ above the footway.
3. Any overhanging lamp or its supports fixed not less than 7′ 6″ in clear above the footway immediately below and so as not to project anywhere beyond the line of the window frame of the shop more than 3′ and not nearer the carriage-way than 2′ 6″ from the outer edge of the kerb. Such a lamp shall be used solely to illuminate the windows from without, and it must not exceed 36″ in height, 24″ in width parallel to the face of the building and 24″ in depth from back to front of lamp in the clear, including any ornamentation.
4. Any overhanging gas rail or pipe used for illuminating the shops from outside which does not project more than 2′ from the shop front and is not less than 7′ 6″ above the footway immediately beneath.
5. Any overhanging daylight reflector or prismatic light which does not project more than 2′ 6″ from the face of the building and not less than 7′ 6″ above the surface of the footway immediately beneath.

(End of digest of London Byelaws.)

Outside London there is no power to make similar byelaws but local authorities have certain powers under section 69 of the Towns Improvement Clauses Act, 1847, and section 24 of the Public Health Act, 1925 (where in force) subject in each case to a right of appeal to Quarter Sessions.

RAILS, BEAMS, WIRES, ETC., OVER STREETS

Section 25 of the Public Health Act of 1925, where in force, prohibits, except by consent of and subject to the conditions laid down by the local authority, the fixing of any rail, beam, pipe, cable, wire or similar thing over any street. There is a right of appeal to Quarter Sessions. Section 26 prohibits the placing of any post, aerial or wireless apparatus over any street, or over any place to which the public, whether by payment or otherwise, may have access.

SKY SIGNS

Section 91 of the Public Health Acts Amendment Act, 1907, (which may be put into force by order of the Home Secretary in any district outside London) prohibits, when it is in force, subject to certain transitional savings any sky sign in connexion with any building, and defines a sky sign as follows :—

> Any word, letter, model, sign device or representation in the nature of an advertisement, announcement, or direction supported on or attached to any post, pole, standard, frame-work or other support wholly or in part upon, over, or above any house, building or structure, which, or any part of which sky sign shall be visible against the sky from some point in any street or public way, and includes all and every part of any such post, pole, standard frame-work or other support.
>
> The expression " Sky sign " shall also include any balloon, parachute or other similar device employed wholly or in part for the purposes of any advertisement or announcement on, over or above any house, building, structure or

erection of any kind, or on or over any street or public way. It shall not include any flagstaff, pole, vane or weather-cock unless adapted or used wholly or in part for the purpose of any advertisement or announcement ; neither any sign nor board, frame or other contrivance securely fixed to or on the top of the wall or parapet of any building, or on the cornice or blocking course of any wall, or to the ridge of a roof : provided that such board, frame, or other contrivance be of one continuous face and not open work, and do not extend in height more than 3′ above any part of the wall or parapet or ridge to, against or on which it is fixed or supported.

There are substantially similar provisions in London.

PAINT

The subject is exhaustively treated in Post-War Building Study No. 5 "The Painting of Buildings" (H.M.S.O., 1944, 1s. 0d. net) in which the latest developments in materials and technique are surveyed.

See also list of British Standards, p. 173, and references at the end of this Section.

Acute shortages of raw materials, particularly linseed and other oils, at present place severe restrictions on the use of paints and distempers. The following Memorandum from the Ministry of Works, dated September, 1946, sets out permitted practice under existing conditions :—

MINISTRY OF WORKS INTERIM ECONOMY MEMORANDUM ON THE USE OF PAINTS AND DISTEMPERS

(September, 1946)

The urgent need for economy in the use of linseed oil necessitates the issue of this interim economy memorandum. The memorandum deals with the use of certain known protective coatings under known conditions : it deals mainly with site work on permanent buildings of traditional types.

In drawing up the schedule given below the following guiding principles have been adopted :—

(1) For purely decorative purposes paints containing linseed or other fatty oils should not be used.

(2) Preference in the use of paint should be given to permanent over temporary buildings.

(3) Preference in the use of paint should be given to protection against corrosion and decay of the essential structural parts of buildings over less important parts except where the latter are difficult and costly to paint due to inaccessibility.

(4) The functions of different buildings and parts of buildings as well as the destructive and contaminating conditions concerned must be taken into account, e.g., hospitals, dairies, kitchens, exposure to severe atmospheric conditions, etc.

It is realised that the recommendations given below necessitate a considerable departure from good practice and a general lowering of standards which may in some instances lead to increased maintenance costs. When restrictions on the use of linseed oil are removed and re-painting of surfaces previously treated with wood preservatives, tar paints and silicate paints is required, special consideration will be necessary regarding preparation and the use of sealing coats.

Attention is drawn to the fact that in using the fewer number of coats of paint specified in the schedule better results, as regards protection and hiding power, are obtained by using darker paints instead of white and light tints. Moreover opaque white pigments are in short supply.

SCHEDULE

Except where otherwise stated paints used in maintenance work should, where possible, be similar in type to those used originally. Paints, distempers or stains containing linseed or other fatty oil must not at present be used when repainting surfaces previously treated with cement paints, silicate paints, tar, tar paints or wood preservatives, all of which are in good supply and may be used for all new or maintenance work without restriction.

For exterior painting the order of preference shown in the schedule should be observed unless good and sufficient reasons to the contrary exist. This does *not* apply to *interior* painting, for which the alternatives are optional.

Throughout this schedule the word "paint," used without qualifications, means all paints containing linseed or other fatty oil. The selection and approval of paints within the limits of this schedule are responsibilities of the user.

1. IRON AND STEEL (EXTERIOR)

Category	New Construction	Maintenance
(1) Structural iron and steel prior to being enclosed within cavities.	One coat quick-drying anti-corrosive primer, followed by two coats bitumen or tar.	
(2) All galvanised iron including window frames.	Paint not to be used on exposed surfaces.	If needed on account of rusting, touch up with Primer to B.S. 1011 type 2, or other anti-corrosive primer and follow with one coat aluminium paint.
(3) Stanchions, girders, window frames and sashes, exterior surfaces of ungalvanised tanks and cisterns.	One coat primer to B.S. 1011 type 2, or other anti-corrosive primer, followed by two coats paint.	Touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer and follow with two coats paint.

Category	New Construction	Maintenance
(4) Balconies, fire-escapes, guttering, down pipes, soil pipes.	(i) One coat quick-drying anti-corrosive primer, followed by two coats tar paint to B.S. 1070 without oil and with filler, or (ii) One coat primer to B.S. 1011 type 2, or other anti-corrosive primer, followed by two coats paint.	Touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer and follow with two coats paint.
(5) Steel doors and shutters.	(i) One coat primer to B.S. 1011 type 2, or other anti-corrosive primer, followed by one coat aluminium paint or, (ii) One coat quick-drying anti corrosive primer, followed by one coat tar paint to B.S. 1070 without oil and with filler or, (iii) One coat primer to B.S. 1011 type 2, or other anti-corrosive primer, followed by one coat paint.	(i) Touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer, and follow with one coat aluminium paint or, (ii) Touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer and follow with one coat paint.
(6) Ungalvanised sheet.	(i) Two coats tar paint to B.S. 1070 without oil and with filler, or (ii) One coat primer to B.S. 1011 type 2, or other anti-corrosive primer, followed by one coat aluminium paint.	Touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer and follow with one coat paint.
(7) Gates, railings.	(i) One coat quick-drying anti-corrosive primer, followed by two coats tar paint to B.S. 1070 without oil and with filler, or (ii) One coat primer to B.S. 1011 type 2, or other anti-corrosive primer, followed by one coat paint.	Touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer and follow with one coat paint.

II. WOODWORK (EXTERIOR)

(1) Doors and door frames, window frames and sashes. Greenhouses (interior and exterior).	One coat primer to B.S. 929 P1, followed by one coat undercoat paint (exterior quality) and one coat finishing paint (exterior quality).	Touch up with primer to B.S. 929 P1, follow with one coat undercoat paint (exterior quality) and one coat finishing paint (exterior quality).
(2) Weatherboards, out-buildings and sheds including doors and window frames thereof, gates, fences.	Wood preservative to B.S. 1282 type A excepting that, provided the raw material position allows, wood preservative to B.S. 1282 type B may be used. In some instances where exceptionally severe climatic conditions exist, one or two coats tar, or tar paint to B.S. 1070 (without oil and with filler) should be used. Paints or other treatments containing linseed or other fatty oil not to be used.	Touch up with primer to B.S. 929 P1, and follow with one coat paint.
(3) Balconies or verandahs, barge-boards, gutter-boards.	(i) Wood preservative to B.S. 1282 type A, excepting that, provided the raw material position allows, wood preservative to B.S. 1282 type B may be used or, (ii) One coat primer to B.S. 929 P1, followed by one coat undercoat (exterior quality) and one coat finishing paint (exterior quality).	Touch up with primer to B.S. 929 P1, follow with one coat undercoat paint (exterior quality) and one coat finishing paint (exterior quality).

III. STONE, BRICK, CLAY BLOCK, CONCRETE CEMENT RENDERING AND STUCCO (EXTERIOR)

All paints, distempers or other treatments containing linseed or other fatty oil not to be used for either new work or maintenance. In cases where painting may be deemed necessary cement paints are generally suitable for new work although tar may be used where desired. Bituminous emulsions—free from oil—are generally suitable for new work or maintenance.

IV. IRON AND STEEL (INTERIOR)

Category	New Construction	Maintenance
(1) Structural iron and steel prior to being enclosed within cavities.	One coat quick-drying anti-corrosive primer followed by two coats bitumen or tar.	
(2) All galvanised iron including window frames.	Paint not to be used on exposed surfaces.	If needed on account of rusting, touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer and follow with one coat aluminium paint.
(3) Stanchions, girders, roof trusses and the like, window frames and sashes.	One coat primer to B.S. 1011 type 2, or other anti-corrosive primer, followed by two coats paint.	Touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer, and follow with two coats paint.
(4) Exterior surfaces of ungalvanised tanks and cisterns.	Either (*a*) one coat primer to B.S. 1011 type 2, or other anti-corrosive primer followed by two coats paint or (*b*) one coat anti-corrosive primer followed by one coat aluminium paint.	Touch up with primer to B.S. 1011 type 2, or other anti-corrosive primer and follow with two coats paint or one coat aluminium paint.
(5) Pipes, radiators.	One coat primer followed by one coat paint.	Touch up with primer and follow with one coat paint.

V. WOODWORK (INTERIOR)

(1) Window frames and sashes, skylights (excluding those in outbuildings).	One coat Primer to B.S. 929 P1 followed by one coat undercoating paint (exterior quality) and one coat finishing paint (exterior quality).	Touch up with primer to B.S. 929 P1, and follow with one coat paint.
(2) Doors, cupboards, architraves, picture rails, skirting, staircases.	Either (*a*) one or two coats varnish-stain on bare wood or (*b*) one coat primer to B.S. 929 P1, 2, 3 or 4, followed by one coat paint.	Either (*a*) touch up with varnish-stain and follow with one coat oak varnish, or (*b*) touch up with primer to B.S. 929 P1, 2, 3 or 4, and follow with one coat paint, or *c*) where previously grained, touch up where necessary and follow with one coat oak varnish.
(3) Partitions, panelling.	As (2) above, subject to requirements, if any, relating to Fire Precautions.	As (2) above, subject to requirements, if any, relating to Fire Precautions.

VI. BRICK, CONCRETE, CEMENT RENDERING (INTERIOR)

(1) General.	Either (*a*) cement paint or (*b*) silicate paint or (*c*) non-washable distemper.	Either (*a*) cement paint or (*b*) silicate paint or (*c*) non-washable distemper.
(2) Kitchens and Bathrooms.	One coat petrifying liquid followed by one coat oil-bound water paint or washable distemper.	Either (*a*) two coats oil-bound water paint, or, if previously painted with gloss paint, (*b*) two coats flat oil paint.
(3) Hospitals and Dairies.	Either (*a*) one coat primer followed by one coat approved undercoat and one coat hard gloss paint, or (*b*) one coat primer followed by one coat flat oil paint.	Either (*a*) one coat undercoat followed by one coat hard gloss paint or (*b*) two coats flat oil paint.

Category	New Construction	Maintenance
VII. ASBESTOS CEMENT (INTERIOR)		
	As in VI above except that the primer used must be specially approved for the purpose.	As in VI above.
VIII. INSULATING BOARD (INTERIOR)		
	Either (*a*) cement paint or (*b*) silicate paint, subject in both cases to requirements, if any, relating to Fire Precautions.	Touch up with appropriate primer, bring forward and apply one coat of distemper or oil-bound water paint, or, if previously painted, flat oil paint or hard gloss paint.
IX. LIME PLASTER (INTERIOR)		
(1) Ceilings.	Non-washable distemper.	Non-washable distemper.
(2) Walls—General.	Either (*a*) cement paint or (*b*) silicate paint or (*c*) non-washable distemper.	Touch up with appropriate primer, bring forward and apply one coat distemper or oil-bound water paint, or, if previously painted, flat oil paint or hard gloss paint.
(3) Walls—Kitchens and Bathrooms.	Either (*a*) one coat petrifying liquid followed by one coat oil-bound water paint or washable distemper or (*b*) one coat primer followed by one coat flat oil paint.	Touch up with appropriate primer bring forward and apply one coat of distemper or oil-bound water paint, or, if previously painted, flat oil paint or hard gloss paint.
(4) Walls (ceilings if essential)—Hospitals and Dairies.	Either (*a*) one coat primer followed by one coat undercoat and one coat hard gloss paint, or (*b*) one coat primer followed by one coat flat oil paint.	Touch up with appropriate primer, bring forward and apply one coat of distemper or oil-bound water paint or flat oil paint or hard gloss paint.
X. CALCIUM SULPHATE PLASTER AND PLASTERBOARD (INTERIOR)		
(1) Ceilings.	Non-washable distemper.	Non-washable distemper.
(2) Walls—General.	Either (*a*) non-washable distemper or (*b*) one coat petrifying liquid followed by one coat oil-bound water paint or washable distemper.	Touch up with appropriate primer, bring forward and apply one coat of distemper or oil-bound water paint, or, if previously painted, flat oil paint or hard gloss paint.
(3) Walls—Kitchens and Bathrooms.	Either (*a*) one coat petrifying liquid followed by one coat oil-bound water paint or washable distemper or (*b*) one coat primer followed by one coat flat oil paint.	Touch up with appropriate primer, bring forward and apply one coat of distemper or oil-bound water paint or, if previously painted, flat oil paint or hard gloss paint.
(4) Walls (ceilings if essential)—Hospitals and Dairies.	Either (*a*) one coat primer, followed by one coat undercoat and one coat hard gloss paint or (*b*) one coat primer followed by one coat flat oil paint.	Touch up with appropriate primer, bring forward and apply one coat of distemper or oil-bound water paint or flat oil paint or hard gloss paint.

(END OF MINISTRY OF WORKS MEMORANDUM.)

SPRAY PAINTING

Painting by means of a spray diffuser can frequently be employed with advantage. For intricate metal work, radiators, lift enclosures, etc., it is particularly good, as it provides a smooth even surface which would be almost impossible with brushing. It is also valuable for painting or distempering places which are difficult of access.

It is not usual to specify the number of coats in spray work, but the quality of finish required—which should conform to sample.

RADIATOR PAINTING

Heat transmission values for radiator paints are approximately :— (but see also p. 34.)

Bare Iron Surface	1·0
White Enamel or White Zinc Paint ...	1·01
White Lead Paint	·987
Copper Bronze	·76
Aluminium Bronze	·752

It will thus be seen that the common practice of painting radiators with aluminium paint is not a good one.

Discoloration on radiators coated with a glossy surface is largely due to the fact that the varnish, which floats to the surface to give the glossy effect, is the portion of the enamel or paint most subject to discoloration under heat. With a flat finish discoloration would be very slight.

SPREADING CAPACITY AND WEIGHT

Spreading capacity refers to the area painted. Covering capacity refers to the opacity of the paint.

The spreading capacity of various materials depends upon the surface to be painted and upon the skill of the painter.

1 gallon of paint will cover 60 to 80 yds. super in one coat.

7 lb. of washable distemper plus thinning solution will cover 30 to 35 yds. super in one coat.

1 gallon of varnish will cover about 80 yds. super in one coat.

The weights of materials are as follows :—

1 gallon ready mixed lead paint, glossy finish, weighs 26–28 lb.

1 gallon ready mixed flat paint, weighs 33–35 lb.

Other ready mixed paints vary in weight per gallon according to the colour and the proportion of extender employed, and may be as low as 9½ lb. in the case of a Finishing Gloss Black.

1 gallon of linseed oil weighs 8¾ to 9 lb.

1 gallon of turpentine weighs 8½ lb.

1 firkin of size weighs 28 lb.

FRENCH POLISH

To specify this treatment the following clause may be used : " Prepare, full fill, and polish, and to a finish approved by the architect."

If a semi-gloss is required, specify " Prepare, full fill, polish and dull down to a finish approved by the architect."

GILDING

Gilding may be done with Gold Leaf or real Gold Powder, the latter being used only for water gilding, the former for both water and oil gilding. Water gilding is gold leaf or real gold powder laid with a water gold size. Oil gilding is gold leaf laid with oil gold size. Gold Leaf is beaten gold and the quality known as " Best English " (a little over 23 carat) is beaten to a thinness of 2,000 leaves each 3¼" square to 1 oz. of gold.

Leaf is known as Single and Double Gold Leaf :—

Single Gold Leaf = 2,000 sheets 3¼" × 3¼" to 1 oz.

Double Gold Leaf = 1,000 sheets 3¼" × 3¼" to 1 oz.

Leaf is made up in book form and a " Book " contains 25 leaves. The covering capacity is about 17 leaves to a superficial ft. on a flat surface.

Gold Leaf is made up in a variety of colours and this is done by the addition of alloys.

Gold Powder is pure gold in a powder form and must not be confused with bronze powders in various " Gold " colours.

Its qualities are the same as pure gold leaf and its use is generally for intricate carved or modelled work where difficulty would be experienced in laying leaf in water gilding.

PREPARATION FOR GILDING

Surfaces to be gilded are prepared as under :—

Ironwork :	2 coats at least of good oil paint.
Woodwork :	Priming and 2 coats at least of good oil paint.
Furniture :	5 or 6 coats of Parchment Size and Whitening.
Plasterwork :	Size or Stopping solution and 2 or 3 coats of good oil paint.

All surfaces must be well rubbed down.

References

P.W.B.S. No. 5. " The Painting of Buildings." (H.M.S.O.) 1944. 1s. 0d.

Bibliography, p. 161.

Also Bulletins of the Paint Research Association, Waldegrave Road, Teddington, particularly :

No. 16. " Preservation of Iron and Steel by means of Paint."

No. 22. " Preparation of Metal Surfaces for Painting."

No. 26. " Priming Joinery Timber."

No. 29. " Decoration of New Plaster and Cement."

No. 34. " Painting Treatment of Non-ferrous Metals."

PAPER HANGING

A " piece " of English paper is nominally 12 yds. long, but actually 11½ yds. long by 21" wide, and contains 63 sq. ft., or 7 sq. yds.

Except for irregular areas such as staircases, the wastage allowance is one piece in seven : hence to find the required number of pieces to cover any area, divide the total number of sq. yds. to be covered by six. The following Paperhanger's Card may be found of use :—

WALL-PAPER TABLE

For finding the number of pieces of wall-paper, English size, required for any room. Measure round the four walls in ft., including doors, windows, etc.

Height in Feet from Skirting to Cornice	Length of Four Walls in Feet 28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100 round room
7 and under 7½	4	4	5	5	6	6	7	7	8	8	8	9	9	10	10	11	11	12	12 pieces of paper
7½ ,, 8	4	4	5	5	6	6	7	8	8	9	9	10	10	11	11	12	12	13	13 ,, ,,
8 ,, 8½	4	5	5	6	6	7	7	8	8	9	9	10	10	11	12	12	13	13	14 ,, ,,
8½ ,, 9	4	5	5	6	7	7	8	8	9	9	10	11	11	12	12	13	13	14	14 ,, ,,
9 ,, 9½	4	5	6	6	7	7	8	9	9	10	10	11	12	12	13	13	14	15	15 ,, ,,
9½ ,, 10	5	5	6	7	7	8	9	9	10	10	11	12	12	13	14	14	15	15	16 ,, ,,
10 ,, 10½	5	5	6	7	8	8	9	10	10	11	12	12	13	14	14	15	16	16	17 ,, ,,
10½ ,, 11	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	16	16	17	18 ,, ,,
11 ,, 11½	5	6	7	8	8	9	10	10	11	12	13	13	14	15	16	16	17	18	18 ,, ,,

CEILING PAPER TABLE

Table to estimate paper required for ceilings. For use in average rooms, but not for passages, etc.

Measurement in Feet round four Walls of Room	20 to ...28	30 to 40	42 to 48	52 to 58	60 to 66	68 to 70	72 to 78	80 to 82	84 to 88	90 to 92	94 to 98	100 to 104
No. of Pieces required	1	2	3	4	5	6	7	8	9	10	11	12

BOX PAPERS

Box papers are those normally used in the fancy goods and box covering trade. They include coloured, embossed, metal foil and wood veneer papers, which are sometimes employed for wall coverings. They are supplied in different sizes varying for the many types of paper, the most commonly occurring sizes being 20″ × 30″, 20″ × 25″, 18″ × 23″, and 23″ × 36″—of which the size 20″ × 30″ is by far the most common.

For comparison, the number of sheets required to cover the same area as a roll of English wall-paper (21″ × 12 yds.), is approximately as follows :—

20″ × 30″	...	15 sheets
20″ × 25″	...	17 „
18″ × 23″	...	22 „
23″ × 36″	...	11 „

The usual count for box papers is the ream of 480 or 516 sheets varying with the type of paper. It is also sold at per 1,000 sheets.

The following table shows the price of box papers per ream of 480 sheets 20″ × 30″ compared with that of wall-paper 21″ × 12 yds., per piece :—

	per ream		per piece
Box paper at	40s. 0d.	is equivalent to wallpaper at	1s. 3d.
„ „	50s. 0d.	„ „ „	1s. 7d.
„ „	60s. 0d.	„ „ „	1s. 10d.
„ „	70s. 0d.	„ „ „	2s. 2d.
„ „	80s. 0d.	„ „ „	2s. 6d.
„ „	90s. 0d.	„ „ „	2s. 10d.
„ „	100s. 0d.	„ „ „	3s. 2d.
„ „	110s. 0d.	„ „ „	3s. 5d.
„ „	120s. 0d.	„ „ „	3s. 9d.
„ „	130s. 0d.	„ „ „	4s. 1d.
„ „	140s. 0d.	„ „ „	4s. 5d.

PARTY WALLS

(See under "Walls," p. 151.)

PAVEMENT LIGHTS

In London application must be made to the City Corporation or to the Borough Council concerned. No standard projections beyond the building-line exist, as such projections may depend on the width of the footpath and other conditions. Each case is considered on its merits. Generally, however, the allowable projection of pavement lights varies from 12″–18″. The actual construction must comply with the byelaws of the L.C.C. or City Corporation. After being constructed, they must, by the Metropolis Management Act, 1855, be kept in good order by the owner.

Outside London pavement lights are mentioned in section 35 of the Public Health Acts Amendment Act, 1890, which requires them to be kept in good order, but there is no such detailed control as in London.

PAVING

PAVING OF YARDS

Outside London, section 56 of the Public Health Act, 1936, empowers local authorities, subject to appeal to a Court of Summary Jurisdiction, to require yards of houses and passages giving access to houses to be paved. In London, section 41 of the Public Health (London) Act, 1936, empowers metropolitan borough councils to require the drainage of courts, etc., adjacent to houses. The Metropolis Management Acts, 1855, and 1862, contain provisions similar to the provincial law, the appeal, however, being to the L.C.C. and not to the Courts.

STONE PAVING

This may be laid directly upon rammed earth, but it is common practice to lay paving slabs on sifted ashes or sand. For pavements and courtyards the slabs are usually laid on a bed of lime mortar and jointed either with the same material or with cement mortar.

York and Purbeck slabs are usually 2″ to 3½″ thick : Portland stone slabs usually 2″ thick.

York stone slabs can be obtained up to any transportable size : Purbeck up to 3′ × 2′.

Portland Stone, unless unusually thick, should not be used in large sizes owing to the risk of cracking.

The following list gives the standard dimensions for artificial stone paving (B.S. 368 : 1936) :—

Length	Breadth	Thickness
3′	2′	2″ and 2½″
2′ 6″	2′	2″ and 2½″
2′	2′	2″ and 2½″
1′ 6″	2′	2″ and 2½″

BRICK PAVING

Brick Paving is preferably laid on a concrete bed at least 3″ thick.

GRANOLITHIC PAVING

See under "Flooring," p. 67.

FLOOR TILES

(See under "Tiles," page 138.)

PRECAST TERRAZO TILES

These are made in various sizes, the usual sizes being 9″ × 9″ and 12″ × 12″.

MEASUREMENT

The following data on paving will be found useful :—
1 sq. yd. of paving requires 32 bricks laid flat, i.e., 9″ × 4½″ on face ; 1 sq. yd. of paving requires 48 bricks laid on edge, i.e., 9″ × 3″. Add to the last two items an allowance for lesser size of bricks laid either flat or on edge, since sizes are nominal only ; laid flat generally reckoned 36, laid on edge 52. 1 sq. yd. of 4″ × 4″ paving tiles requires 81 tiles net ; 1 sq. yd. of 6″ × 6″ paving tiles requires 36 tiles net. 1 ton granite setts 6½″ deep will cover 3½ yds. super.

PERAMBULATORS

DIMENSIONS OF PERAMBULATORS

AVERAGE MODELS

Length	55″ to 57″
Width	28″ to 29″
Height (hood down)	35″ to 38″
Height (hood up)	49″ to 50″
Height of handles	35″ to 36″

SMALL MODELS

Length	47″
Width	27″
Height (hood down)	28″
Height (hood up)	44″
Height of handles	35″

PIANOS

Type	Length	Width	Height	Weight
Concert Grand Piano...	7′ to 9′	4′ 11″ to 5′ 6″	3′ 3″	1040 lb.
Small Grand Piano ...	4′ 6″ to 5′	5′		590 lb.
Upright Piano	4′ 2″ to 4′ 4″	2′	4′ 8″	625 lb.

PILES

GENERAL DESCRIPTION

Where a bed of soft clay, peat, running sand or other soft material lies below the surface of the ground on which foundations are to be laid, piles may be driven to penetrate to firm material, so that the loads from the structure can be carried suitably, without settlement.

Pile formulae are very controversial and should be used with great caution. It is advisable that test borings be taken on the site to be piled and test piles sunk. Accurate readings should be taken of the sinking during driving and also of the strata through which the bore passes. Test loads should be applied to determine the amount of settlement, if any, and to decide the safe load per pile.

PRECAST PILES

Precast reinforced concrete piles are frequently used in preference to timber piles. They must be designed not only to withstand the stresses due to static loads and to driving, but also the bending stresses due to slinging from the ground to their position in the driving frame.

IN SITU PILES

In addition to the precast concrete pile, there are a number of methods by which a concrete pile is cast *in situ* in the ground. These methods consist usually of boring a hole of suitable size to the required depth, with or without a steel tube liner and filling the hole thus formed with concrete and suitable reinforcement, the tube or liner being withdrawn as the concrete is placed. In many cases the concrete is placed in position under pressure, the liner being withdrawn gradually as the concrete rises and allowing the concrete to be forced outwards to form slight projections or collars.

In all cases in which it is proposed to use concrete piles, care should be taken to ascertain that the strata through which the pile passes does not contain substances such as calcium sulphate, which might act deleteriously on the cement.

It is claimed for piles placed *in situ* under pressure that they may be adopted in positions where the headroom would not allow of any ordinary driving methods, and also where noise and vibration would be an annoyance and danger.

TIMBER PILES

Timber piles are still used extensively, especially for marine and temporary works. Certain woods where intended for permanent use should be impregnated under pressure with creosote or some other preservative. Timbers in common use are Pitch and Oregon pines, Teak, Oak, Memel, Jarrah and Greenheart.

SHEET PILES

Sheet piles are used where it is necessary to retain the soil or water and prevent it falling into an excavated space. They usually consist of interlocking steel members, driven to the required depth and held at the top by walings, struts or other suitable means.

SCREW PILES

Screw Piles consist of a stem, which is the actual pile, shod with a screw disc or plate having a thread of approximately one and a half turns.

The piles may be of wood, cast iron or wrought iron, but the disc is usually of cast iron.

They range in size from 6″ to 18″ pile diameter, with discs of from 4 to 6 times the pile diameter.

They should be of circular section to provide easy turning and are usually sunk by means of hand power, operating long levers in a capstan head fixed to the pile top.

The smaller sizes are usually solid, but the larger sizes are hollow, and frequently filled with concrete to provide additional strength.

PIPE CHASES AND TRENCHES

Where possible, pipes should be grouped in chases or trenches : they should be accessible, and, where removable covers cannot be fixed, crawling space should be provided. All water pipes in trenches and chases should be covered with non-conducting material.

SEPARATION OF PIPES IN TRENCHES

Where pipes connected to different services, e.g., gas, electricity, telephones, water, etc., are run in the same range of trenching, it is advisable to provide separation, particularly between gas and electricity, telephones and electricity, and water and electricity, and to paint or otherwise mark the various services to enable them to be easily distinguished (See B.S. 617 : 1942. Identification of Pipes in Buildings).

Separation may be effected by the use of sheets of metal or asbestos cement, or the trench divided by thin partition blocks.

It is difficult to separate services in a vertical chase, and usually simpler and cheaper to provide separate chases.

NOTCHING OF JOISTS

Where notching is necessary for the passage of pipes, this should be done as close as possible to the supports, and in no case near the middle of the joist. In old buildings joists or binders should not be notched for pipes.

PIPE SLEEVES

In all cases where pipes pass through walls or floors, the holes should be guarded by means of sleeves, preferably of metal, to allow free movement due to expansion and contraction. Sleeves should be cut and finished off to allow wall, ceiling or floor finishing to be applied, and the gap between pipe and sleeve should be kept free, and if necessary for acoustic reasons, the sleeve should be large enough to allow for proper caulking.

In some conditions it is possible to provide a central pipe duct or chamber with access at each floor level. In this case fire regulations may necessitate the sealing of the duct at each floor level.

PIPE CHASES (OTHER THAN LEAD PIPES)

In the following table allowance has been made for joints and working space.

Size of Pipe inches	No. of Pipes 1	2
	Inches	Inches
½ to 1	4½ × 4½	9 × 4½
1½	9 × 4½	9 × 4½
2	9 × 4½	14 × 4½
3	9 × 9	14 × 9
4	9 × 9	18 × 9

APPROXIMATE OVERALL SIZES OF LEAD WIPED JOINTS

Diam. of pipe in.	Max. diam. of Joint in.	Diam. of pipe in.	Max. diam. of Joint in.
½	1½	2½	3½
¾	1⅞	3	4
1	2¼	3½	4½
1¼	2⅝	4	5
1½	2⅞	5	6⅛
2	3⅛	6	7⅛

PIPE CHASES FOR LEAD PIPES WITH WIPED JOINTS

Diam. of Pipe In.	Overall size of chase in.
up to $\frac{3}{4}$	$2\frac{1}{2} \times 2\frac{1}{2}$
over $\frac{3}{4}$ up to $1\frac{1}{4}$	3×3
over $1\frac{1}{4}$ up to 2	4×4
over 2 up to 4	6×6
over 4 up to 5	8×8
over 5 up to 6	9×9

Note.—Where lead pipes are supported by means of lead tacks wiped to the backs of the pipes, the width should be approximately 2″ greater in each case after 2″ diameter pipes given above.

Where vertical lead pipes 3″ diameter and over are supported by lead collars or flanges, the sizes of chases may be as follows :—

Diam. of Pipe in.	Overall size of chase for one pipe in.
up to 4″	9×9
over 4″ and up to 6″	12×12

PIPE TRENCHES

In the following table allowance is made for covering materials, joints and working space :—

Size of Pipe inches	No. of Pipes 1	2	3	4
	inches	inches	inches	inches
$1\frac{1}{2}$	9×9	12×9	15×9	18×9
2	9×9	15×9	18×9	18×9
$2\frac{1}{2}$	9×9	15×9	21×9	24×9
*3	9×9	18×9	21×9	24×9
*4	9×9	18×9	24×9	30×9
*5	12×12	21×12	27×12	36×12
*6	12×12	21×12	32×12	38×12

Note.—In cases where the runs are longer than 50′, all trenches for pipes marked * must be increased in depth to allow the provision of the requisite fall, and flange pits must be provided as required.

DRAINAGE PROVISIONS

Pipe trenches should be laid to fall and have a drainage outlet. Where it is not possible to drain directly into the main system, as in basements below sewer invert level, a sump should be provided. In such a case the boilers and the lower portions of the heating and hot water services could not be emptied directly into the sewer, and the sump should be of sufficient capacity to receive the whole of the contained water at one time.

In relatively small buildings, say up to 100,000 cu. ft., a semi-rotary hand-pump would be a sufficient provision to deal with sump clearing, but for larger installations an electric motor-driven pump should be considered, controlled by means of a float switch, the discharge from the pump in either case being taken direct to the sewer.

Reference

Institution of Civil Engineers " Report of Joint Committee on Location of Underground Services." 1946. 6d.

PIPE LAGGING

(See " Lagging," p. 79.)

PLASTERING

SAWN WOOD LATHS

A bundle contains 500′ run of lath.

Lengths of laths vary from 3′ to 6′, increasing 6″ at a time.

Single fir laths are $\frac{1}{8}$″ to $\frac{3}{16}$″ thick by 1″ wide.

Lath-and-half laths are $\frac{3}{16}$″ to $\frac{1}{4}$″ thick by 1″ wide.

Double laths are $\frac{1}{4}$″ to $\frac{3}{8}$″ thick by 1″ wide.

Laths should be spaced not less than $\frac{3}{16}$″ and not more than $\frac{3}{8}$″ apart.

Normally 80′ run of laths and 100 nails are required for a superficial yard of lathing.

See B.S. 1317 : 1946. " Wood Laths for Plastering."

SPLIT WOOD LATHS

Split laths are normally supplied in bundles of 300′ run and in lengths from 2′ to 4′ 6″ rising by 6″ at a time ; thicknesses are the same as for sawn laths.

LATH NAILS

The laths should be secured with wire lath nails about $1\frac{1}{4}$″ long, having large flat heads ; they should be galvanised to prevent rusting.

METAL LATHING

Steel in the form of expanded and perforated metal is now ordinarily used for lathing, especially in fire-resisting structures. Plaster becomes more firmly attached to metal lathing and is not so easily loosened by slight movements. The metal lathing should be protected from rusting by galvanizing or coating with some preservative, especially when a calcium sulphate plaster is employed. These include some varieties of " Keene's cements " and various proprietary plasters. If heavily gauged with lime the acidity is neutralised and corrosion reduced ; it is better, however, to protect metal lathing, and any other metal coming into contact with the plaster by at least a wash of portland cement slurry ; or, better still, by a coat of portland cement-sand mortar, in addition to the usual galvanising or enamel coating.

In addition to the weakening of the structure, rust-stains may soon appear on the surface of white plaster if unprotected metal lathing is corroding behind it. In the case of water seepage or heavy condensation, any calcium sulphate plaster may have a corrosive action.

Plaster applied over lathing, either metal or wood, is generally specified to be three-coat work, i.e., render, float and set. Plaster applied direct to a solid backing such as brickwork or concrete may be carried out in either two or three coats. Plastering on solid walls and partitions is most often carried out in three coats, while that on the underside of solid ceilings is almost invariably two-coat work, i.e., render and set. It is important that the first coat should have a definite strength in order that the keys may support the weight of the plaster and resist vibration at an early period. This is of particular importance in ceiling work both over lathing and on the solid. The material used for the first coat should, therefore, have a definite chemical set such as is found with the use of a hydrated hydraulic lime, portland cements, or a calcium sulphate plaster, e.g., proprietary hardwall or Keene's. If a non-hydraulic lime is used strength must be obtained by gauging with cement or plaster. Subsequent coats may be less strong.

LIME

Lime used in plastering is obtained by slaking quicklime, i.e., calcium oxide, or calcium oxide together with a smaller proportion of magnesium oxide, which will react to give a hydrate when brought into contact with water. It may contain as further ingredients (not " impurities ") varying proportions of soluble silica and alumina (and iron oxide) which are able to impart to it a moderately hydraulic character.

A quicklime used for plastering should be one which, when properly slaked or hydrated, gives a sound putty of sufficient workability, i.e., of a " fat " nature.

The degree of workability demanded by the plasterer varies from one district to another and depends on the character

of the local lime to which the craftsman is accustomed, and on the mode of slaking usually adopted.

(*a*) *Quicklime*—Slaked on the Site.

The slaking should be carried out by a skilled operative accustomed to the particular type of lime in use, and not left to an unskilled labourer. If unsoundness is to be avoided care must be taken to avoid burning or drowning and to pass the run lime through a fine screen, discarding any stone or larger particles which have escaped slaking. The slaking of the lime should be carried out as long as possible before use—preferably not less than three weeks : the putty should then be stored in a covered bin or pit to stiffen up and mature.

An hydraulic lime slaked in this way and stored for some time before use will very largely lose its hydraulicity, but it may still be suitable for plastering in positions where hydraulic set and high strength are not essential.

(*b*) *Dry Hydrated Lime.*

Commercial dry hydrates (marketed often under proprietary names) are limes hydrated or slaked on a large scale in such a manner that the excess of water is driven off by the heat generated in the process, and a fine dry powder results. The product is then generally very finely screened. Hydrated lime should be carefully distinguished from (*a*) finely ground quicklime ; (*b*) air-slaked quicklime that has fallen to powder. The latter is of little value, and may be dangerous in use.

Building limes are specified in B.S. 890 : 1940 and compliance with this specification should be demanded.

The majority of dry hydrates yield, when soaked in water, a putty or paste which is not so workable as those obtained from quicklime direct, and one which has lower sand-carrying capacity. They offer, however, the great advantage of not requiring slaking on the site but merely mixing with water and soaking for a short time. If properly prepared, also, the problem of unsoundness is effectively solved.

Some white hydrates show a preliminary stiffening or false set when used unsoaked, but lose this rapidly when soaked and knocked up for some little time after the addition of water, afterwards behaving like run white lime putties. On the other hand, hydraulic hydrates show a definite set, even in damp situations, when used unsoaked like cement. After soaking for not more than 2 hours they still show a definite set, but to a diminished degree.

CALCIUM SULPHATE AND ANHYDRITE PLASTERS

B.S. 1191 : 1944 " Gypsum and anhydrite building plasters," classifies these plasters into five groups as follows :

Class A Plaster of Paris.
B Retarded hemihydrate gypsum plasters.
C Anhydrous gypsum plaster.
D Keene's or parian plasters.
E Anhydrite.

For each class chemical composition, purity, freedom from coarse particles, soundness, transverse strength, and where applicable, mechanical resistance and expansion on setting, are specified, together with appropriate methods of test.

The issue of this Standard has removed much of the confusion surrounding the specification of plaster, due largely to the multiplication of trade names. Plasters should always be specified to comply with the appropriate Class in B.S. 1191 ; a product of known properties is thus obtained and misunderstanding avoided.

The following notes on the composition and characteristics of some of the above classes may be of use.

Class D. Keene's or parian plasters.

These plasters are in most cases obtained by the calcination of mineral gypsum at temperatures in the neighbourhood of a dull red heat, followed by fine grinding ; they can also be made by utilising natural minerals which have the same composition and properties as the hard burnt gypsum. In both cases even the fine powder would be almost devoid of set except for the addition of an accelerator (usually alum, potassium sulphate or other soluble sulphates) in suitable proportions—about ½ to 2 per cent is a usual amount. The resulting product commonly has an initial set in from 2 to 8 hours, and should have a final set within about 16 hours. Lime must not be added to certain of these plasters, though with others such an addition is permissible and improves the workability. The advice of the manufacturer of the plaster should be sought on this question.

Such hard-burnt plasters, if properly accelerated, give the highest strength and can be trowelled to a hard glazed surface. They are, therefore, used in high class work in positions where great hardness is required. Since there is practically no expansion or contraction on setting, cracks should not develop in the finished surface.

On account of the presence of the accelerator, which is often of an acidic character, such plasters are prone to corrode metal : with some accelerators which contain salts of alkalies, difficulties may arise with painting fresh plasterwork (see " Paint," p. 106). These plasters normally dry out slowly, especially when steel-trowelled to a hard finish, and are prone to condensation. If suddenly dried, as when applied as a thin finishing coat over a porous background, they may fail to set properly and the otherwise exceedingly high adhesion may not be developed. Numerous failures have been traced to this cause and hard burnt plasters should, therefore, be maintained damp for some time after application, and any high suction of the backing killed by a thorough hosing of the surface before application.

Class A. Plaster of Paris (Hemihydrate).

Class B. Retarded Hemihydrate Plasters.

The hemihydrate plasters are prepared by the calcination at a comparatively low temperature of mineral gypsum. They contain about 5 to 9 per cent of water, mostly still in combination. Their mode of set is completely different from that of Class D and is very much quicker. The product is more porous and generally weaker than set hard-burnt plaster, but considerably stronger than a lime plaster.

In Class A, unretarded, or Plaster of Paris, the initial set will generally take place in about 5 minutes, but may range from two minues to half-an-hour according to purity and freedom from particles of set plaster. The setting time depends also on the water—and the temperature. This class is useful only for casting and running mouldings, etc., and for gauging lime putty in small quantities at a time.

In Class B (sometimes called " hardwall plasters ") the set is retarded by the addition of a small proportion (generally a few pounds per ton only) of a glue-like substance called the " retarder." Three qualities are specified in B.S. 1191 suitable for undercoats, finishing coats and " dual-purpose " work respectively. A properly retarded plaster of the " undercoat " quality will set in rather over two hours, with a final set but little more ; the " finishing " quality is generally made with a rather quicker set, in order to avoid the possibility of a " dry-out " on the wall, i.e., in order to avoid the danger of the plaster drying out before the set is complete. The set is greatly accelerated by the addition of lime but is scarcely affected by a small addition of quick-setting Plaster of Paris.

These plasters are of value especially for trowel application on the wall, since, in addition to possessing a convenient setting time and rapid development of strength, there is actually a small net expansion in setting instead of a contraction. This reduces the likelihood of the development of cracks. Such a plaster should be practically neutral, and, therefore, unusually safe for early decorations and the degree of freedom from condensation is found to compare well with lime plaster. The workability and sand-carrying capacity is generally rather below that of " run " lime putty. Since no alum accelerator is present, lime putty can safely be added ; but as stated below, such an addition accelerates the set, and may make it as short as 15 to 35 minutes, depending on the temperature, etc. The time between the initial and final set of these plasters is always short, much shorter than the Class D or Keene's cement type ; there is, therefore, less danger of premature drying whilst, because it is more porous, the set plaster dries out completely in less time.

Other Plasters.

In addition to the calcium sulphate plasters discussed above there are certain traditional types and many proprietary brands of plaster on the market.

Most of the plasters sold under proprietary names are found to be included in Classes A to D above. Where the type of the proprietary plaster is not disclosed, it can only be suggested that the maker's instructions be followed explicitly, and that they should be consulted in any case of doubt as to the methods of handling the material.

SAND

Sand used for plastering is described in various terms such as clean, loamy, sharp, hungry, etc. These terms refer sometimes to the cleanliness of the sand, and sometimes to the type of grading. "Sharp," especially, refers here only to the feel of the sand as imparted to it by the type of grading and does not refer to the possible angular nature of the sand particles. Specifications for sand usually ask for a "Clean Washed Sand." If strictly complied with, this material would be found very harsh to work. Actually it is very difficult to wash a sand really clean, and sands sold as washed sands will usually contain a little loam.

The use of a sand containing up to 6 per cent by weight of loam can be tolerated in lime and in essentially lime mixes. The value of the loam lies in the increased workability which it imparts to the plaster ; but with lime or cement plasters too much loam will cause excessive shrinkage. In addition, a very loamy sand will greatly retard the set.

With a retarded hemihydrate (hardwall) plaster (Class B above) a loamy sand can be used ; but with Class D plasters, a clean sand must be adopted, since the presence of loam will materially affect the setting of this type of plaster.

The sand for undercoats should all pass a B.S. No. 5 or $\frac{3}{16}''$ sieve, and should preferably be well graded, i.e., with particle sizes varying from coarse to fine ; a very fine uniform sand is not desirable. For finishing work the sand must be clean and should all pass a B.S. No. 18 sieve, unless a coarser sand be desired for a special type of finish.

HAIR IN PLASTER

Hair is added to mixes used for undercoats over lathing and must be long-fibred and clean, and well and uniformly distributed. The modern practice is to add one-third to one half-pound of hair per cu. ft. of coarse stuff, and this reduces droppings and facilitates application. In addition, it helps in the formation of well-shaped keys and in this manner increases the adhesive strength of the plaster to lathing. The actual effect of this quantity of hair on the tensile strength per sq. in. of set dry mortar is, however, shown by experimental tests to be negligible.

When badly distributed in tufts and bunches, and when short fibred—as is often the case under modern conditions—the hair is useless. The old practice was to add much more hair—at least 3 to 4 lb. per cu. ft. of coarse stuff. When good hair was well mixed in such amounts, it is probable that a finished plaster was obtained having useful hair re-inforcement of the keys, and, therefore, much more able to resist vibration than the under-haired plaster of today.

PLASTERING ON METAL LATHING

The following specification for plastering on metal lathing has been recommended by a specialist firm :—

The pricking-up coat and render coat should be made up as follows :—The coarse stuff should be composed of three parts of sand to one of lime putty, the latter being run from chalk lime at least 14 days before being used. One pound of hair should be well mixed with every three cu. ft. of coarse stuff, and one part of portland cement with eight parts of coarse stuff.

The pricking-up coat and the render coat should be applied as soon after one another as possible, and should then be left as long as practicable before the setting coat is applied. In no circumstances should this period be less than three days : better results are obtained if the render coat can be left to dry for two months.

The finishing coat should consist of lime setting stuff gauged with a suitable gypsum plaster. Plaster of Paris is not recommended for gauging, and gypsum or any of the patent hard-setting plasters should not be used for pricking-up or render coats as the excess of acids in these materials will undoubtedly set up rapid corrosion.

The sand should be passed through an $\frac{1}{8}''$ sieve and should be free from loam : this is important, as loam is the principal cause of contraction and subsequent cracking.

FIBRE BUILDING BOARD

(B.S. 1142 : 1943 with Addendum 1945 for fire retardant boards.)

Fibre Building Board is a modern material used either as a plaster substitute or as a base to replace lathing.

Most types are available in widths of 4,′ 5′ and 6′ with lengths of 8′, 12′ or 16′. Insulating board is made in widths of 4′ or 6′ and lengths of 8′, 10′ or 12′.

PLASTER-BOARD

A further development is the gypsum wall-board or plaster-board, consisting generally of a central slab of plaster faced and reinforced on each side with stout paper, which is nailed directly to studding or joists. The plaster-board has a rough fibrous surface to take a thin neat finishing coat of plaster. Boards may also have a finished surface on one side, the joints of which may be filled with neat plaster.

Plaster-board has the advantage over some other types of wall-board that it is free from appreciable moisture movement, i.e., expansion and contraction with changes of moisture conditions. It is, therefore, not so essential to cover the joints of such boards with strips of wood or other material. Gypsum plaster board is standardised by B.S. 1230 : 1944, which defines types and qualities. The various types are available in sizes ranging between a width of 2′ 4″ with a length of 3′ 0″ up to a maximum length of 12′ with a width of 3′ or 4′. It is obviously desirable that studs, joists, or battens to which fixing is to be made should be spaced to suit the sizes used.

PLATFORMS AND STANDS USED ON PUBLIC OCCASIONS

Section 37 of the Public Health Acts Amendment Act, 1890, is in force in most boroughs and urban districts, and some rural districts, and requires that roofs, platforms, balconies, etc., where persons are likely to assemble on the occasion of any entertainment, public procession or open air meeting, shall be safely constructed or secured to the satisfaction of the surveyor to the local authority. There is no appeal from his refusal to be satisfied. The London Building Acts contain special provisions, as do local Acts of Parliament in many provincial towns.

PLUMBING

EXTERNAL PLUMBER

LEAD FLATS

Sheet lead for flats (and gutters) is laid in lengths up to about 10′ for ordinary work. Rolls should be 2″ in diameter and spaced about 2′ 9″ apart. Drips should be 2″ deep and should be spaced 8′ to 10′ apart. Boarding to flats and gutters should be laid in the direction of the fall, which should never be less than 1″ in 10′. As a general rule no single piece of lead used should be more than 24 sq. ft. in area excluding turn ups.

WEIGHT AND THICKNESS OF SHEET LEAD

Weight in lbs. per ft. super	Thickness in inches	Nearest simple fraction of an inch
1	·017	1/60
2	·034	1/32
3	·051	1/20
4	·068	1/16
5	·085	1/13
6	·101	1/10
7	·118	1/9
8	·135	1/8
9	·152	1/7
10	·169	1/6

Milled sheet lead is rolled in sheets 20′ to 35′ long and 6′ to 9′ wide. The general width is 7′.

Milled sheet lead for various positions should be of the following minimum weights :—

Roofs, flats and main gutters	5 to 7 lb. per sq. ft.
Small gutters, ridges, hips and valleys	5 to 6 „ „
Flashings and aprons	5 „ „
Soakers	3 to 4 „ „
Linings to cisterns and sinks	7 „ „

Note.—4 lb. lead is sometimes used for small flat roofs not subject to traffic.

GUTTERS

The narrowest part of a long gutter should not be less than 6″ wide. Short gutters behind chimneys, etc., may be 6″ wide. The lead should be turned up not less than 6″ against walls ; under slates or tiles on roof slopes it should be carried up to a distance of 6″ when measured vertically from the sole of the gutter.

COVER FLASHINGS

These should be about 6″ wide, including the inch let into the wall.

Stepped flashings are 12″ to 15″ wide where no soakers are used, and average about 7″ wide where the latter are used.

Cover flashings on patent glazing in exposed positions should be fitted with special storm clips.

SOAKERS

These should turn up 2½″ to 3″ on the vertical face, and should lie along the roof surface for a distance equal to half the width of the slate or tile. The length is usually the gauge plus the lap plus 1″.

SNOW-BOARDS

These are made of wood battens about 2″ by 1″ and from 1″ to 1½″ apart : they should be fixed on shaped supports and are used in parapet and other similar gutters. The wood should be coated with preservative before assembling. Snow guards should be fitted to the eaves of roofs overhanging glass roofs.

GUTTERS AND DOWN-PIPES

Under Section 39 of the Public Health Act, 1936 any spout or rainwater pipe which is " insufficient " may be required (by the local authority subject to a right of appeal to a Court of Summary Jurisdiction) to be renewed or repaired.

Under Section 40 of the Public Health Act, 1936, no pipe conveying rain water may be used for carrying off any soil water and no pipe used for carrying off any surface water shall be used as a ventilating pipe to any drain or sewer conveying foul water.

These provisions do not apply in London.

SIZES OF GUTTERS AND DOW-NPIPES

Rain-water pipes should have an internal area of not less than 1 sq. in. for every 100 sq. ft. of roof surface (measured on plan). The distance apart of the rain-water pipes is regulated by the capacity of the gutter. For domestic work, generally, the down-pipes should not be further apart than 40′. The depth of the normal half-round cast iron gutter is usually less than half its diameter.

The following data is based on a storm rainfall in the British Isles of a maximum of 3″ per hour, plus a generous safety margin and allowing for one outlet. For sloping roof surfaces the equivalent flat area is the plan area.

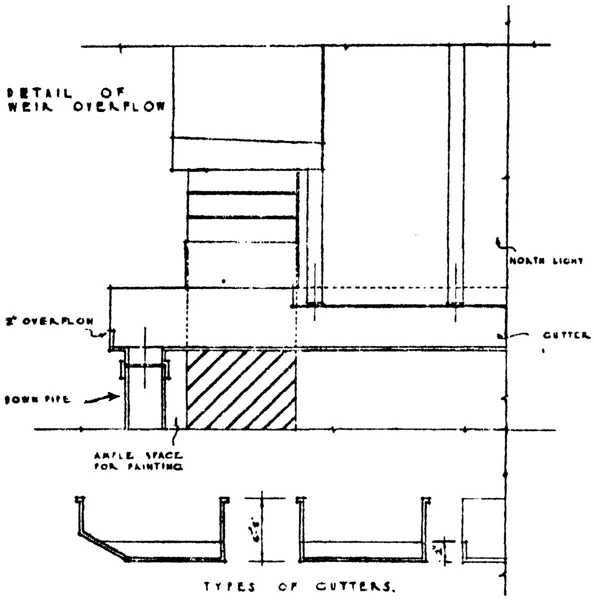
Suitable for a Flat Surface to be drained of Area :—	Size of Gutter	Gross Sectional Effective Gutter Area sq. in.	Essential Internal Diam. of Gutter Outlets	Down-pipe Diam. in.
	MOULDED GUTTER			
550 sq. ft.	4″ × 3″	7¾″	3″	3″
1,000 sq. ft.	5″ × 4″	12¾″	3″	3″
1,600 sq. ft.	6″ × 5″	19½″	4″	4″
	HALF ROUND			
300 sq. ft.	4″	4½″	2½″	2½″
390 sq. ft.	4½″	5¼″	2½″	2½″
560 sq. ft.	5″	7¼″	3″	3″
	OGEE GUTTERS			
250 sq. ft.	4″	4½″	2½″	2½″
330 sq. ft.	4½″	5½″	2½″	2½″
450 sq. ft.	5″	7″	2½″	2½″

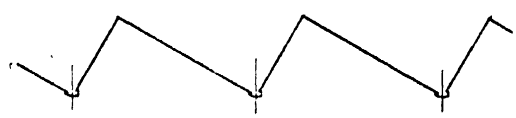
While in practice a 2″ pipe will effectively drain a 4″ half-round or ogee gutter, the risk of choking due to leaves, etc., makes its use undesirable.

In cases where there is a tendency for gutters to fill with dead leaves it may be desirable to use even a larger size gutter and down-pipe than this table indicates. But any advantage gained in this way would be entirely lost if the rain-water head outlet or gutter outlet is so tapered that its effective internal diameter is less than that of the down-pipe used.

In large roofs of north light or similar construction, it is often desirable to use gutters of sufficient width to allow walking space.

In some districts the surface water sewer is insufficient in size to deal with very heavy rain, and rain-water pipes should be increased in size while the intercepting trap or traps should be provided with anti-flood valves. Internal roof gutters, such as those between a series of north light roofs, should have weir overflows at the ends to provide for extra heavy down-pours, or in case the down-pipes should become choked. Also there should be no means of outlet internally such as rain-water heads between the gutter and the sewer ; for in the event of the sewer water flooding up the drain, the rain-water pipes will fill up and the weir overflow and the gutter will act as an outlet. (See diagram below.)





STANDARD RAINWATER FITTINGS

British Standards exist for pipes and fittings in cast iron (light, medium and heavy grades), sheet steel, and asbestos cement. Rainwater goods in cast aluminium are also manufactured. The following are leading particulars from the B.S.S. concerned :

B.S. 460 : 1944. Cast Iron Spigot and Socket Rainwater Pipes, Accessories and Fittings.

LIGHT RAINWATER PIPES

	Nominal Size	2 in.	2½ in.	3 in.	4 in.	5 in.	6 in.
Pipe		in.	in.	in.	in.	in.	in.
	Int. dia.	1⅞	2⅜	2⅞	3⅞	4⅞	5⅞
	Ext. dia.	2⅛	2⅝	3⅛	4⅛	5⅛	6⅛
	Thickness ...	⅛	⅛	⅛	⅛	⅛	9/64
Socket	Int. diam.	2 7/16	2 15/16	3 7/16	4 7/16	5 7/16	6½
	Ext. diam.	2 23/32	3 7/32	3 23/32	4 23/32	5¾	6⅞
	Thicness	9/64	9/64	9/64	9/64	5/32	3/16
	Depth	2½	2½	2½	2½	3	3
Ears	Length of flange ...	5⅛	5⅝	6⅜	7½	8½	10
	Centre to centre of holes	3⅞	4⅜	5⅜	6¼	7½	8½
		lb.	lb.	lb.	lb.	lb.	lb.
	Minimum weight in lb. per 5 ft. length, exclusive ears ...	15	17	21	29	40	52

MEDIUM AND HEAVY RAINWATER PIPES

	Grade	Heavy			Medium					
	Nominal Size	3"	3½"	4"	2"	2½"	3"	3½"	4"	6"
Pipe	Constant int. dia. min.	in. 3	in. 3½	in. 4	in. 2	in. 2½	in. 3	in. 3½	in. 4	in. 6
	Thickness min.	13/64	13/64	13/64	3/16	3/16	3/16	3/16	3/16	3/16
	Constant ext. dia. max.	3 13/32	4	4⅜	2⅜	2⅞	3 13/32	4	4⅜	6⅜
	Thickness min.	13/64	13/64	13/64	3/16	3/16	3/16	3/16	3/16	3/16
Socket	Constant int. dia. min.	3 29/32	4⅛	5	2⅞	3⅜	3 29.64	4⅛	5	7⅛
	Thickness min.	9/32	9/32	9/32	¼	¼	¼	¼	¼	¼
	Constant ext. dia. max.	4 15/32	5⅛	5⅝	3⅜	3⅞	4 15/32	5⅛	5⅝	7¾
	Thickness min.	9/32	9/32	9/32	¼	¼	¼	¼	¼	¼
Ears	Length of flange	7	7⅝	8⅝	5¾	6¾	7	7⅝	8⅝	10⅞
	Centre to centre of holes	5¾	6⅝	7⅛	4⅛	5⅛	5¾	6⅝	7⅛	9¼
Minimum weight of pipe in lb., exclusive of ears. Effective length 5 ft.		lb. 35	lb. 42½	lb. 48	lb. 21	lb. 26	lb. 30½	lb. 36	lb. 40	lb. 63

FITTINGS FOR LIGHT RAINWATER PIPES

Fitting	Angles, etc. degrees	Nominal size in.
Bends	92½, 112½ and 135	2, 2½, 3, 4, 5 and 6
Shoes, and anti-splash shoes	—	2, 2½, 3, 4, 5 and 6
Branches, equal (single or double)	92½, 112½ and 135	2, 2½, 3, 4, 5 and 6
Offsets	Projections of 2½, 3, 4½, 6, 9 and 12 in. for all sizes	2, 2½, 3, 4, 5 and 6
Diminishing pieces	—	2/2½, 2/3, 2½/3, 2/4, 2½/4, 3/4, 2½/5, 3/5, 4/5, 3/6, 4/6 and 5/6
Union sockets	—	2, 2½, 3, 4, 5 and 6
Inspection pieces (oval access doors)	—	2, 2½, 3, 4, 5 and 6
Holderbats	—	2, 2½, 3, 4, 5 and 6
Wire balloons	—	2, 2½, 3, 4, 5 and 6

FITTINGS FOR MEDIUM AND HEAVY RAINWATER PIPES

Fitting	Angles, etc. degrees	Nominal size in.
Short radius bends, with or without access doors, and with or without heel rests	92½, 95, 100, 112½, 120 and 135	2, 2½, 3, 3½, 4 and 6
Offsets	Projections of 3, 4½, 6, 9 and 12 in. for all sizes	2, 2½, 3, 3½, 4 and 6
Branches, equal, with or without access doors	92½, 95, 100, 112½, 120 and 135	2, 2½, 3 3½, 4 and 6
Branches, double, equal, with or without access doors	92½, 95, 100, 112½ and 120	2, 2½, 3, 3½ and 4
Branches, unequal, with or without access doors	92½, 95, 100, 112½, 120 and 135	3/2, 3½/2, 3½/3, 4/2, 4/3, and 6/4
Branches, unequal, double, with or without access doors	92½, 95, 100, 112½ and 120	3/2, 3½/2, 3½/3, 4/2
Diminishing pieces	—	2½/2, 3/2, 3/2½, 3½/2, 3½/2½, 3½/3, 4/2, 4/2½, 4/3, 4/3½, 6/3½, 6/4
Inspection pieces (oval access doors)	—	2, 2½, 3, 3½, 4 and 6
Loose sockets	—	2, 2½, 3, 3½, 4 and 6
Collars	—	2, 2½, 3, 3½, 4 and 6
Shoes	—	2, 2½, 3, 3½, 4 and 6
Holderbats	—	2, 2½, 3, 3½, 4 and 6
Wire balloons	—	2, 2½, 3, 3½, 4 and 6
Rainwater heads, hopper type—flat and corner	—	2, 2½, 3, 3½, 4, 5 and 6
Rainwater heavy square type—flat		2, 2½, 3, 3½, 4, 5 and 6

B.S. 1205 : 1945. Cast Iron gutters and Fittings.

The standard effective length is 6' in nominal sizes of 3", 4", 4½", 5" and 6".

B.S. 1091 : 1942. Pressed Steel Rainwater Gutters, Pipes and Fittings.

Pipes and fittings, of nominal internal diameters, 2," 2½", 3", 3½" and 4".

O.G. and half-round gutters of nominal sizes, 3", 3½", 4", 4½", 5" and 6".

Thicknesses	Pipes, 22 B.G. Gutters, 20 B.G.
Finish	Galvanized. (For War Emergency black tar paint to B.S. 1070).
Lengths	3', 4' and 6', inclusive of internal length of socket.

B.S. 569 : 1945. Asbestos Cement Spigot and Socket Rainwater Pipes and Fittings.

Pipes. Sizes :

Internal diameter	in.	2	2½	3	4	5	6
External diameter	in.	2½	3	3⅝	4⅝	5¾	6¾

Effective lengths : 6' and 10' for 2" to 4" pipes, 6' for larger sizes.

Fittings.—The standard fittings are as follows :

Bends :
- Radius. Angles 90°, 100°, 110°, 120° and 135°.
- Swan neck. Projections from 3" to 24".
- Plinth. Projections 2¼", 3", 4½" and 6".

Branches :
- Equal, single and double, and "Y" pieces.

Rainwater Heads :
- Circular, hexagonal and cistern types.

Rainwater Shoes and Loose Sockets.

Gutters.—Half-round : Width 3", 4", 4½", 5" and 6".
'O.G.,' :—Width 4", 4½", 5" and 6".

Valley gutters :	Type A. 16", 18" and 24". Type B. 12".
Boundary wall gutters :	Type A. 11", 12" and 18". Type B. 16".
Box gutters :	5", 12" and 15".

INTERNAL PLUMBER

HOT WATER CYLINDERS AND TANKS

The following are sizes for domestic use standardized by B.S. 417 : 1944 :

GALVANIZED M.S. CYLINDERS

Size No.	Dimensions: Internal dia.	Dimensions: Height	Capacity: Nominal	Capacity: Actual
	in.	in.	gal.	gal.
3·1	15	36	23	21
3·2	18	30	28	25
3·3	18	36	33	30
3·4	18	42	39	36
3·5	20	51	58	55
3·6	24	48	78	73
3·7	24	63	105	95

In 3 grades A, B and C according to thickness of plate.

GALVANIZED M.S. HOT WATER TANKS

Size No. gal.	Nominal capacity gal.	Actual capacity gal.	Outside dimensions: Length ft. in.	Outside dimensions: Width ft. in.	Outside dimensions: Back to front ft. in.
2·1	20	17	2 0	1 4	1 3
2·2	25	21	2 0	2 0	1 0
2·3	30	25	2 0	1 6	1 7
2·4	30	27	2 0	2 0	1 3
2·5	35	39	2 6	1 6	1 6
2·6	40	34	2 3	1 8	1 8
2·7	50	46	2 5	1 10	1 10
2·8	60	53	2 6	1 11	2 0
2·9	70	64	3 0	2 0	1 11

The above are made in two grades, Grade A for 15' working head of water. Grade B for 10' head.

COPPER HOT WATER CYLINDERS

B.S. 699 : 1944 specifies the following dimensions :—

B.S. No.	Dimensions: Ext. dia. in.	Dimensions: Height in.	Capacity: Nominal gal.	Capacity: Actual gal.
1	14	36	20	18
2	16	36	25	23
3	18	36	30	29
4	18	42	40	34
5	21	48	60	53
6	24	48	75	69
7	24	63	100	93

Cylinders are made from copper sheet to B.S. 899 : 1940 in three grades :—

	Test pressure lb. per sq. in.	Working head of water, feet
Grade 1	70	100
2	40	60
3	20	30

COLD WATER CISTERNS

Standard sizes in galvanized mild steel (with open top) from B.S. 417 : 1944 are as follows :—

(See table over page.)

Size No.	Nominal capacity	Actual capacity	Dimensions Length	Width	Height
	gal.	gal.	ft. in.	ft. in.	ft. in.
1·1	6	3¾	1 6	0 9	0 11
1·2	10	6	1 6	1 0	1 0
1·3	15	11	2 0	1 0	1 3
1·4	30	22	2 0	1 6	1 7
1·5	35	26	2 0	1 8	1 8
1·6	40	30	2 3	1 8	1 8
1·7	50	40	2 5	1 10	1 10
1·8	62½	50	2 6	2 0	2 0
1·9	65	50	3 0	2 0	1 9
1·10	75	60	3 0	2 0	2 0
1·11	100	80	3 0	2 6	2 2
1·12	100	80	3 2	2 3	2 3
1·13	125	100	3 2	2 6	2 7
1·14	250	200	5 0	3 0	2 8
1·15	350	300	5 0	3 9	3 0
1·16	500	425	6 0	4 0	3 4
1·17	600	525	6 0	4 0	4 0
1·18	1000	800	8 0	5 0	4 0
1·19	1250	1000	10 0	5 0	4 0

The above are made in two grades, Heavy and Light.

PRECAUTIONS IN THE USE OF LEAD

Where lead pipes pass through walls it is desirable to sheathe the embedded portion in bituminous felt.

When lead is in contact with moist timber, corrosion is liable to occur. This is particularly the case with oak. Lead sheeting should have an underlay of bituminous felt when laid on oak boards.

Where pipes and lead sheathed wires pass through oak, both the oak and the lead should be painted with shellac varnish, where it is impracticable to wrap the lead.

Lead is liable to be attacked by acetic acid fumes. Care should, therefore, be taken in the use of, say, lead covered bars for roof glazing where acetic acid fumes are present, such as in the manufacture of foods stuffs containing vinegar.

The Building Research Station reports that Portland cement mortar and lime mortar in contact with lead are liable to cause corrosion.

References

P.W.B.S. No. 4. "Plumbing." (H.M.S.O.) 1944. 1s. 0d.

P.W.B.S. No. 13. "Non-ferrous Metals." (H.M.S.O.) 1944. 1s. 0d.

List of British Standards, p. 173. Sizes of Pipe Chases, p. 109.

E. Molloy. "Plumbing and Gas Fitting." (Newnes). 1946. 15s. 0d.

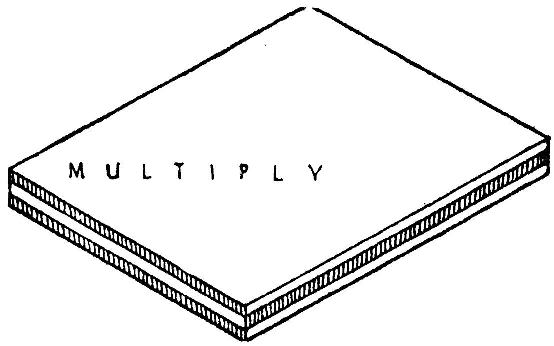
R. H. Winder. "Plumbing." (Longmans, Green). 1946. 7s. 6d.

List of C.D.A. publications under "Copper," p. 46.

PLYWOOD

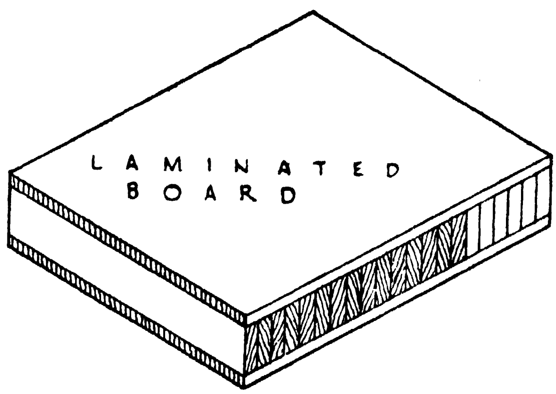
There are four main types of plywood commonly available.

1. MULTI-PLY



These are sheets built up of three or more thin veneers laid with the direction of the grain of each sheet at right angles to that of the preceding sheet. Thicknesses vary from less than ⅛″ to about 1″. Stock up to ¼″ is generally of three ply construction ; thereafter there is no special rule, except that, since the face plies normally run in the same direction, it will rise by odd numbers. There is no relation between thickness and number of plies, and consequently no justification for the common practice of using the number of plies as a specification of thickness.

2. LAMINATED BOARD



These are boards constructed with a built-up core consisting of a number of laminations or strips not over ¼″ thick, cemented together and cross banded with thick veneers.

3. BLOCK BOARD

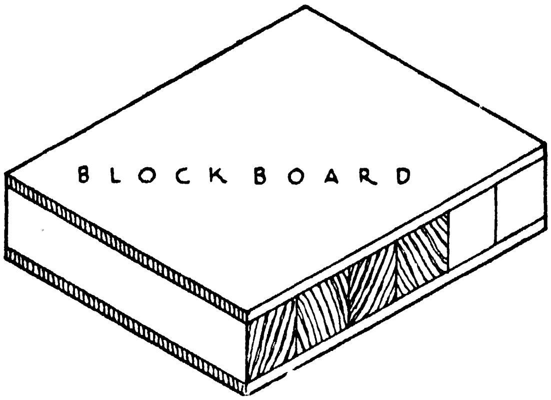
(See sketch over page.)

These are similar to laminated boards but have thicker strips or laminations, varying between ¼″ and 1″ thick. The section of each member of these cores is generally about square.

4. BATTEN BOARD

(See sketch as for Block boards.)

These are again similar, but with still wider cores—from 2″ to 6″ wide—and of similar woods.



BRITISH STANDARD

B.S. 588 : 1935 establishes a standard grading for ply-woods. There are four grades, according to quality and occurrence of permissible defects. The material to be used as core or base is to be specified by the purchaser.

WOODS AND USUAL STANDARD SIZES

The principal woods in which plywood is obtainable in normal times and the usual standard sizes are as follows :—

BIRCH

48″×48″ ; 50″×50″ ; 60″×48″ ; 60″×60″ ; also many of what are termed "as falling" sizes and a small percentage of larger sizes. Panels up to say 84″ × 48″ are manufactured, but the cost is much higher.

ALDER

48″ × 48″ ; 60″ × 48″, with "as falling" sizes. Exceptionally large sizes, but often with joints on the face veneers (suitable for linings), can be obtained at reasonable cost.

GABOON MAHOGANY (OKOUME)

48″ × 36″ ; 48″ × 48″ ; 60″ × 36″ ; 60″ × 48″ ; 72″ × 36″ ; 72″ × 48″ ; 84″ × 36″ ; 84″ × 48″ ; 96″ × 48″ ; 96″ × 60″ ; 120″ × 48″ ; 120″ × 60″ ; other sizes within these limits are also available.

OREGON PINE

Lengths : 60″, 66″, 72″, 84″, 96″.
Widths : 18″, 24″, 30″, 36″, 48″.
Larger panels are also manufactured.

SWEDISH AND NORWEGIAN PINE

60″ × 48″ ; 60″ × 60″ ; 72″ × 60″ ; 84″ × 60″.

OAK

48″ × 48″ ; 60″ × 48″ ; 72″ × 36″ ; 72″ × 30″ ; 48″ × 30″ ; 48″ × 36″ ; 60″ × 30″ ; 60″ × 36″. Larger sized panels are also available, such as 72″ × 59″ ; 84″ × 59″ and 96″ × 59″.

ASH

Principally lengths of 60″ and 72″ and widths of 30″ and 36″.

The above are the more generally used kinds of plywood, but plywood is also commonly available faced either one or both sides in hardwoods such as Walnut, Honduras and Sapele Mahogany.

THICKNESSES

In most ordinary types of woods, thicknesses are available from ⅛″ up to 1″. Boards with built-up cores are available from ½″ to 1¾″ in thickness. In some cases, thicknesses are quoted in millimetres, the equivalent in English measure being as follows :—

3 mm.	⅛″	12½ mm.	½″
4 mm.	5/32″	15 mm.	⅝″
4½ mm.	3/16″	19 mm.	¾″
5 mm.	3/16″ full	22 mm.	⅞″
6 mm.	¼″	25 mm.	1″
9 mm.	⅜″		

LAMINATED BLOCK AND BATTEN BOARDS

Laminated and similar boards are generally made in the size 59″ × 177″. but larger sizes are available. Batten boards can also be obtained faced with Oak, Walnut and Mahogany in sizes up to approximately 150″ × 59″.

PRECAUTIONS IN THE USE OF PLYWOOD

The back of plywood when used for panelling, especially when fixed to damp walls, should be protected with one or two coats of a bituminous, or in some cases an aluminium, paint, and where possible adequate ventilation should be arranged. In addition, consideration should be given to the preservation—by creosote or other impregnation—of the fixing battens and plugs. (Before using any such material it should be ascertained that it will not stain through the facing ply.) It will be understood from consideration of the structure of plywood that this material is so made as to balance out any internal stresses due to moisture changes. It is, therefore, normally advisable, particularly where the ply is unsupported by rigid framing, to treat each side similarly. One side only should never be veneered or otherwise altered without similar work being done upon the reverse side, as there is a risk of unequal pull and subsequent warping in such cases.

POSTER SIZES

Double Royal, 25″ wide by 40″ deep.
Quad Royal, 50″ wide by 40″ deep.
Double Crown, 20″ wide by 30″ deep.
Quad Crown, 40″ wide by 30″ deep.
16-Sheet, 80″ wide by 120″ deep.

POST OFFICE TELEPHONES

(See also "Telephones and Telephone Boxes," p. 133.)

For all buildings in which telephones are required, ample provision for the installation of the wiring and instruments is necessary, particularly if it is desired to conceal the wiring or provide recesses for the instruments.

If notice of a projected building is sent to the local Post Office Engineer or to the Engineer-in-Chief, General Post Office, the Department will arrange for early and experienced collaboration with the Architect or Consulting Engineer. This course should always be adopted.

The Telephone Service carries out the installation of all the actual wiring required and supplies the instruments, switch board, distribution frame, etc. ; but no conduits or other covering are provided. For all buildings in which the permanent positions of telephone instruments and accessories cannot be determined at the outset, some form of draw-in system should be provided, and it should be sufficiently comprehensive and elastic to allow of extensions and alterations without undue disturbance to the structure. Cables serving telephones, bells or signalling devices must be kept in separate conduits or casings from those used for the general electricity supplies ; but it is possible, and indeed usual, to run the services in parallel conduit or casing runs, using inspection or draw boxes which are common to all services, but which are so divided internally as to provide adequate and complete separation.

GENERAL

The majority of pumps are driven by means of an electric motor through suitable gearing or connections, and great care should be taken to ensure that their operation is silent. Complete silence is difficult to obtain, but a degree of silence known as "domestic" should be specified.

All pumps should be fitted with adequate and easy means of priming in case of lost suction through leaky joints, leaky or worn glands or packing, or a faulty foot-valve. Centrifugal and rotary pumps only operate at small suction heads, and their actual capacity should be ascertained from the makers.

Submersible electric pumps operating at the lower end of the suction pipe have manifest advantages in many circumstances. The theoretical horse-power of the motor or other engine required to drive a pump for a given duty may be found by multiplying the product of the weight of liquid dealt with per minute by the total head or distance in vertical travel to which it is to be pumped, and dividing the product by 33,000—the weight being expressed in pounds and the travel in ft. Owing to the fact that the efficiency of any pump may not be comparable with that of another make of pump of similar type, it is very difficult to arrive at the actual horse-power necessary, and this method should only be used as a means of obtaining preliminary data. Efficiencies vary from 15 per cent to 60 per cent for centrifugal pumps, 30 per cent to 60 per cent for plunger pumps and 5 per cent to 50 per cent for rotary pumps, including slip losses.

Reference

P.W.B.S. No. 9 "Mechanical Installations" (H.M.S.O.). 1944. 2s. 0d.

RAMS (HYDRAULIC)

The hydraulic ram is an arrangement whereby the kinetic energy of a large volume of water, under a small velocity head, is utilised to force a smaller volume of water to a greater head or height. The ram consists of (*a*) the supply pipe ; (*b*) the ram and outside valve ; (*c*) the inner valve and air vessel, and (*d*) the delivery pipe.

The supply pipe must have a fall throughout its length and should be from 8 to 12 times the length of the total fall available, i.e., if the total working fall is 2′, the supply pipe should be from 16′ to 24′ in length.

The operation is as follows :—The supply water is allowed to leak through the outer valve until sufficient velocity is attained to raise the valve, thus stopping the flow suddenly and causing an increase of pressure in the ram. This increase of pressure opens the inner valve, and the water flows into the vessel and thence to the delivery pipe. When equal pressure is restored between the supply pipe and the ram, the operation is repeated and continues so long as the flow is maintained. Any reasonable fall or velocity will serve to operate a ram, but the greater the fall (up to about one-quarter of the height to which the water is to be delivered) the better and the more economical the plant. Where the working fall is slight it will be necessary to extend the length of the supply pipe to obtain the necessary volume and velocity of water, and in such cases the advice of the ram maker should be obtained before proceeding.

To ensure that the air vessel is kept charged a shifting valve should be fitted : even if not essential, this is a wise provision. In ordinary cases the output of a modern ram is equal to approximately 50 per cent of the kinetic energy in its operation, i.e., the quantity of water delivered × the height to which it is delivered = approximately 0·5 × the quantity of water working the ram × the working fall. Thus, if

V = Volume of water delivered, in cu. ft. per minute.
H = Height to which water is delivered, in ft.
v = Volume of water operating the ram, in cu. ft. per minute.
h = Working fall in ft.

$$\text{then Output (VH)} = \frac{vh}{2} \text{ or } V = \frac{vh}{2H}$$

The above is approximate only and will be influenced by the friction loss in the delivery pipe.

In giving particulars of the flow of water available in any given case—unless the volume is practically unlimited—an exact measurement of the flow of the stream should be obtained. In the case of a very small stream a temporary clay dam may be formed, and a pipe inserted through which the water may be directed into a bucket. The flow should be timed accurately over a period of 30 or 60 seconds, and the quantity delivered in the time carefully measured. For larger streams a notched weir board must be used.

REFRIGERATORS

The sizes of refrigerators range from small cabinets having a capacity of 1 cu. ft. to large divided cabinets of 40 cu. ft. Where ice is required in quantities exceeding a few pounds daily, the usual type of domestic cabinet is not suitable. Most of the standard types are automatic in operation the temperature being under the control of a thermostat ; and given reasonable attention the temperature range is very well kept, provided the doors are kept closed except when access is required. The majority of cabinets provide for the making of small quantities of ice, usually in the form of cubes.

Two distinct types of refrigerators are in common use—those using a Compression system and those an Absorption system. These systems refer to the method employed to maintain the refrigerant in circulation and in a suitable state to abstract heat from the contents of the cabinet.

The Compression type, as the name implies, utilises a mechanical compressor for its circulation system, and involves the use of moving parts. The Absorption system has no moving parts, but requires applied heat in some form—such as gas, electricity or oil—and also running water during the period of operation, excepting the smallest model, which has an internal capacity of 1 cu. ft. The local water supply authority should be consulted before an absorption plant is purchased, in case their charge for water makes any appreciable difference in the running costs. The usual refrigerants used are sulphur-dioxide (SO_2), methylchloride and anhydrous ammonia. With the very small quantities involved in domestic apparatus there is little fear of trouble with any of them, and it is found that, once charged, these plants operate for very long periods without the loss of refrigerant interfering noticeably with the performance. For use in flats or similar groups of domestic premises the installation of a central plant should be considered, with small cabinets fitted in the individual kitchens or larders. This system is in general use and is more economical in operation than a number of smaller plants. The cabinet in such cases consists of the insulated cupboard with a small cooling coil inserted, usually around the ice-making box.

Each cabinet is fitted with its own thermostat and operates independently.
Refrigerators should be specified to comply with B.S. 922 : 1940, in which minimum standards of construction and standards of performance are prescribed.
Overall dimensions of electrical refrigerators for domestic use are standardized by B.S. 1183 : 1944 as follows :—

Storage capacity cu. ft.	Maximum dimensions			
	Height in.	Width in.	Depth in.	BHP (approx.)
2 to 2½	43	23	22	1/6
3 to 3¼	52	25	26	1/6
3½ to 4¼	52	26	26	1/6
4½ to 5¼	58	30	28	1/5
5½ to 6½	58	31	29	1/5
7 to 8	65	35	29	1/5
8¼ to 11	65	49	29	¼
12 to 16	69	51	29	¼
20 to 25	69	65	29	¼

There is no standard for larger sizes, suitable for hotels' restaurants, and similar buildings, but P.W.B.S. No. 9 gives the following dimensions for use as a guide :—

Storage capacity cu. ft.	Width ft. in.	Depth ft. in.	Height ft. in.
15	3 0	2 0	5 3
25	4 0	2 0	5 9
50	4 9	3 3	6 0
100	7 0	3 3	6 11
150	7 0	4 0	7 3
250	7 4	6 10	7 6

It is suggested that the minimum storage capacity required varies from 0·50 cu. ft. per seat for restaurants or canteens seating 100–250 to 0·37 cu. ft. per seat for 500–1,000 seats. Another common rule is to allow ½ cu. ft. of refrigerated storage space per main meal served.
For application to retail shops, dairies, farms, and like buildings see P.W.B.S. No. 9 "Mechanical Installations." (H.M.S.O.) 1944. 2s. 0d.

REFUSE

REMOVAL OF SNOW, DUST AND FILTH

Under Section 72 of the Public Health Act, 1936, the local authority outside London may, and if required by the Minister of Health must, undertake the removal of house refuse and the cleansing of earth closets, privies, ashpits and cesspools. Where they do so, they have power to make byelaws imposing various ancillary duties on householders. Where the local authority do not undertake the work, they have power to make byelaws requiring occupiers of houses to do it. It may be worth noticing that the former power of local authorities to make byelaws requiring householders to cleanse pavements, and to remove snow from the footway adjoining their property, was repealed by the Act of 1936, and few such byelaws (dating from before 1914) now remain in force.

REMOVAL OF TRADE REFUSE

Section 73 of the Public Health Act, 1936, empowers local authorities to undertake the removal of trade refuse, but does not oblige them to do so. If they do undertake the work, they are, however, required to remove trade refuse upon application by the occupier of any premises, who must pay a reasonable sum for their so doing. Disputes are settled in a Court of Summary jurisdiction.

In London, there are broadly similar legal provisions.

REINFORCED CONCRETE

(See at end of "Concrete," p. 40.)

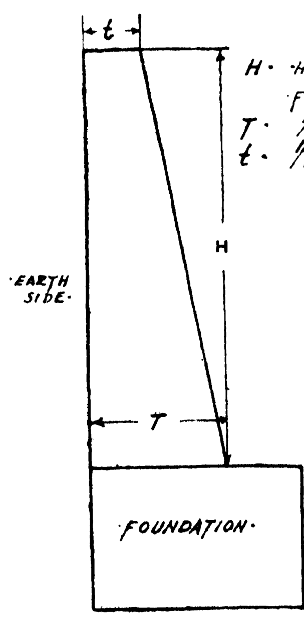
REINFORCED BRICKWORK

See B.S. 1146 : 1943 for stresses and design requirements.

RETAINING WALLS

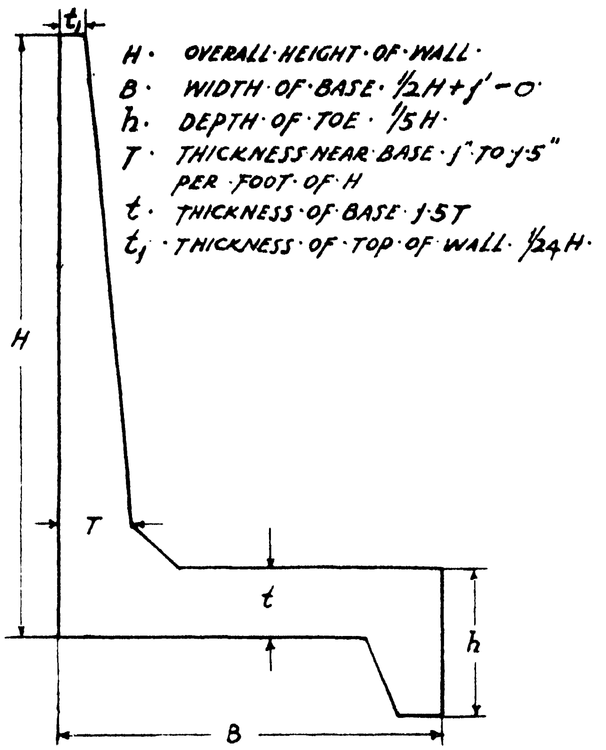
The pressure on the back of a wall depends on the depth to which the wall is carried and the nature of the materials it is called upon to retain. Thus, self-supporting materials—such as hard chalk and rock—require less provision than unstable materials such as clay or gravel.
When subject, or likely to be subject, to damp conditions, the wall should be treated to render it impervious ; unless the conditions are such as will allow of the provision of weep-holes, and so prevent an accumulation of pressure. In most building conditions this provision is not possible, and the wall must be designed to resist the maximum pressure.
The usual types of wall are indicated in the following diagrams :—

1. Usually known as a gravity section, depending on its mass and shape for stability—the shape being a modified rectangle—and designed to increase the acting leverage of the centre of gravity of the section and throw the resultant pressure within the middle third of the base thickness.



TYPICAL GRAVITY SECTION RETAINING WALL

2. A typical reinforced concrete section, with an extended toe : this is frequently more economical than a mass structure. (Diagram over page.)



·TYPICAL SECTION·R·C·RETAINING·WALL·

Practical rules for retaining walls—which must, however, be taken only for preliminary estimating purposes and for average conditions—are set out alongside the diagrams.

Allowance for surcharge depends on the natural slope of the ground, height of surcharge above top of wall, and nature of materials.

In building a retaining wall it is advisable to excavate as necessary for the actual construction, leaving the "dumpling" as a base from which the necessary strutting may be supported until the wall is set.

The foundation must be designed to spread the pressure uniformly and keep it within what the earth will bear without yielding. No generalization is possible, as the allowable pressure must be determined according to the nature of the subsoil. Detail design is a matter for the structural engineer.

ANGLES OF REPOSE OF SOILS

Material		Angle (in degrees)	Weight (lb. per cu. ft.)
Chalk	...	—	125
Earth	Dry ...	29	90 to 95
	Moist	45	95 to 110
	Very wet	17	110 to 120
	Rammed	66 to 74	100 to 110
Gravel	Clean	48	100 to 112
	With sand	26	
Clay	Dry ...	29	120
	Damp, well drained	45	120 to 130
	Wet...	16	135
Shingle	Loose	39	100 to 120
Peat	...	14 to 45	45
Sand	Fine, dry	37 to 31	90 to 112
	Wet	26	112 to 120
	Very Wet	32	128

RUST PREVENTION

GALVANIZING

In this treatment the material is dipped in a bath of molten zinc, the superfluous zinc being allowed to drip off, the residue forming a protective coating. Where it is inadvisable to heat the work to be treated, owing to the danger of warping or loss of temper, the zinc may be electrically deposited.

METALLIZATION

It is possible to apply a coating of metal on almost any material by the process known as metallization, by means of which all metals or alloys which are capable of being drawn into a wire can be applied. The metal is atomised and applied in the form of a spray without the addition of any binder or vehicle, giving a matt finish surface which may be painted if desired. Any thickness of metal may be applied and the thicker coatings are capable of being ground and polished.

SHERARDIZING

This process for the protection of iron and steel consists essentially in the formation of a zinc iron alloy actually in the surface of the metal to be treated. There is practically no alteration in the size of the metal before and after treatment, so that it is possible to sherardize screw threads and moving parts after machining. This is not the case with hot galvanizing. The surface produced is of matt texture, grey in colour and eminently suited as a base for paint. It can be lacquered to prevent the grey matt surface from showing finger and grease marks, and can be buffed and polished. Flaking of the zinc alloy surface is impossible, provided that the work is properly carried out ; it will also stand considerable ill use. The cost compares favourably with hot galvanising for screws and similar very small articles, and the process is most suitable for general ironmongery and fittings. It is expensive and difficult to carry out on bulky goods.

PARKERIZING

This process consists in the formation of a layer of insoluble phosphates upon the surface of the iron or steel to be treated. It is economical and now largely used by the motor trade. There is no limit to the size of parts that can be treated and it is particularly suitable for the treatment of bulky sheet metal work. The finish is a grey-black matt surface which is durable and attractive in appearance.

Reference

B.S.I. Recommendation P.D. 420, November, 1945. "Metal Spraying of Steelwork to Prevent Corrosion."

SANITARY ACCOMMODATION

OFFICE BUILDINGS

Where possible a schedule of the staff should be obtained and the accommodation estimated from the data, including allowances for future increases in numbers of both sexes. Where a schedule is not obtainable the number of occupants may be estimated on the basis of one person per 60 sq. ft. of total floor area, with a separate estimate of the proportion of men to women. The lavatory accommodation may then be computed on the scale laid down by the Factories Act, 1937. Additional lavatories should be installed for the use of principals. Urinals may be estimated on the basis of three stalls per five W.C.'s. Adequate provision for drinking water should be made and drip sinks should be provided for cleaners, and storage space for brooms and pails.

Generally staff lavatories are best placed on all floors except the ground floor, the occupants of which may use lavatories

in the basement. The suites on alternate floors may be allocated to each sex. These arrangements relieve the traffic on lifts and are more economical than concentrating the accommodation in the basements and on the top floors. The principals' lavatories may be entered through the staff lavatories. All lavatories should have mirror and shelf accommodation.

PLACES OF PUBLIC ENTERTAINMENT

(Regulations made by the L.C.C on 30th October, 1928, 16th December, 1930 and 10th February, 1931, No. 2606a, Price 6d. P. S. King and Son, 14, Great Smith Street, S.W.1.)

If required by the Council, each part of the premises used by the public shall be provided with water-closet and urinal accommodation approximately in accordance with the following scale :—

Water Closets

For males : one water closet for the first 200 or part thereof ; two water closets for 200–500 ; three water closets for 500–1,000, and an additional water closet for every 500 or part thereof over 1,000.

For females : one water closet for the first 100 or part thereof ; two water closets for 100–250 ; three water closets for 250–500, and an additional water closet for every 400 or part thereof over 500.

Urinals

In each part of theatres and music-halls one urinal stall for each 50 males. In each part of dancing halls, concert halls, restaurants, cinematograph halls and premises to be used for public boxing, one urinal stall for each 100 males. For the purposes of this regulation it will be assumed that the public in each part of the premises consists of equal numbers of males and females, except that in premises used for public boxing it will be assumed that 90 per cent of the public are males.

In addition to that already specified, such separate accommodation as may be required by the Council shall be provided for the staff and employees and for the performers and the orchestra.

Urinal stalls shall have automatic flushing apparatus, and water closets, urinals, drains, etc., shall be constructed in accordance with the byelaws relating thereto.

The floors of all water closets and urinal apartments, and of the lobbies approaching such apartments, shall be constructed of impervious materials and sloped to a drain. Such apartments shall not, except where unavoidable, be approached from the auditorium or from spaces in which the public await admission.

If lengthy cinematograph displays are to be given regularly, a water closet shall be provided contiguous to the operating enclosure.

Section 44 of the Public Health Acts Amendment Act, 1907, where in force, requires the provision of one or more urinals in a proper position in any Inn, Public House, Beer House, Eating House, Refreshment House, or Place of Public Entertainment. Section 43 permits the local authority to require the removal of any existing urinals opening upon a street which may be a nuisance or offend public decency.

SCHOOLS

The Ministry of Education has issued regulations prescribing minimum provisions for various types of school :—" Regulations Prescribing Standards for School Premises, 1945." (S.R. and O. 1945. No. 345). H.M.S.O. 6d. These should be consulted.

FACTORIES

(Factories Act, 1937 and the Sanitary Accommodation Regulations, 1938.)

Where females are employed 1 W.C. for every 25 females shall be provided. Where males are employed, and where sufficient urinal accommodation is provided, 1 W.C. for every 25 males up to the first 100 and 1 for every 40 thereafter shall be provided. Where the number of males exceeds 500 and where sufficient urinal accommodation is provided, 1 W.C. for every 60 males shall be deemed sufficient. In calculating the number of conveniences required, any number less than 25 or 40 as the case may be, shall be reckoned, as 25 or 40 in a factory not constructed, enlarged or converted since 30th June, 1938, so long as the Medical Officer of Health certifies that the arrangements are adequate. The conveniences shall not communicate with any workroom except through an intervening ventilated space. Separate approaches must be provided for each sex where the conveniences for one sex adjoin those for the other.

SANITARY FITTINGS

Fireclay should be used for all sanitary fittings which are subject to heavy wear, such as in factories, schools and public conveniences.

The drawing on the following page shows some typical Sanitary Fittings. See List of B.S. for the following which refer to common types of fittings : Nos. 1206, 1229, 1244, 1188, 1189, 1213, 1254, 1125, 1255, 1226.

DOMESTIC BATHS

The following are leading dimensions of standard baths, specified in B.S. 1189 : 1944 :—

Dimension	Rectangular (magna)		Tub (parallel)
	in.	in.	in.
Length, overall ...	66	72	66
Width, overall	28	28	29
Width, inside	$22\frac{3}{4}$	$22\frac{3}{4}$	23
Depth, inside (at waste)	$17\frac{1}{2}$	$17\frac{1}{2}$	17
Height overall			
Exclusive of feet ...	18	18	$17\frac{1}{2}$
With feet for $1\frac{1}{2}$ in. seal trap	23	23	$22\frac{1}{2}$
Ditto for 3″ seal trap	$24\frac{1}{4}$	$24\frac{1}{2}$	24

Taps should preferably be $\frac{3}{4}$″ to 1″ in diameter and traps $1\frac{1}{4}$″ for small baths and 2″ in diameter for large baths.

WEIGHTS OF DOMESTIC BATHS (EMPTY)

A cast iron porcelain enamelled parallel bath with 3″ roll and 6′ × $29\frac{3}{4}$″ overall size weighs about 240 lb.

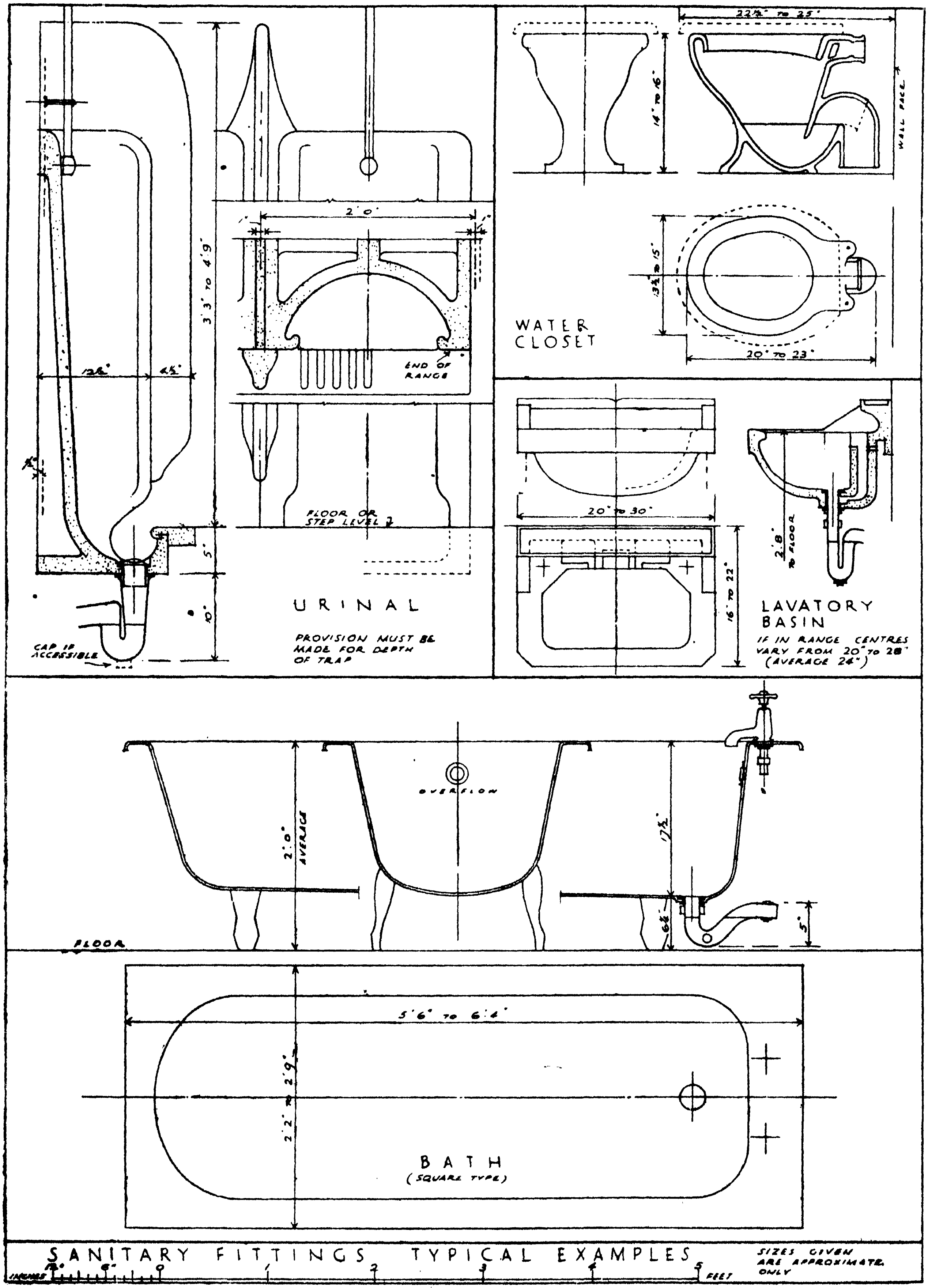
A one-piece cast iron porcelain enamelled parallel bath of similar size to the above but of enclosed (non-standard) type (two ends and one side) weighs about 475 lb.

Fireclay or earthenware baths weigh about 700 lb.

To the above weights should be added about 450 lb., being the inclusive weight of water and user.

SCHOOLS

Under the Education Act, 1944, the Ministry of Education has issued regulations prescribing minimum standards of accommodation, lighting, playing fields and other requirements. These have statutory force and replace the old sets of " Suggestions " issued by the Board of Education before the war.



3' 3" TO 4' 9"
12½"
4½"
5"
10"
CAP IS ACCESSIBLE
2' 0"
END OF RANGE
FLOOR OR STEP LEVEL
URINAL
PROVISION MUST BE MADE FOR DEPTH OF TRAP
22¼" TO 25"
14" TO 16"
WALL FACE
WATER CLOSET
20" TO 23"
20" TO 30"
16" TO 22"
2' 8" TO FLOOR
LAVATORY BASIN
IF IN RANGE CENTRES VARY FROM 20" TO 28" (AVERAGE 24")
OVERFLOW
2' 0" AVERAGE
17½"
5"
FLOOR
5' 6" TO 6' 4"
2' 2" TO 2' 9"
BATH
(SQUARE TYPE)
SANITARY FITTINGS TYPICAL EXAMPLES
SIZES GIVEN ARE APPROXIMATE ONLY
INCHES
FEET

The main body of these regulations is contained in S.R. and O. 345, 1945, "Regulations Prescribing Standards for School Premises, 1945." (H.M.S.O., 6d.) An attempt to digest the Regulations might be misleading, and the full text should be consulted.
See also P.W.B.S. No. 2 "Standard Construction for Schools" (H.M.S.O.) 1944. 6d.
No. 21 "School Buildings for Scotland." (H.M.S.O.). 1945. 1s. 0d.
No. 24 "School Furniture and Equipment." 1946. 6d.
The Studies contain type-plans and much other essential information.

SEWAGE DISPOSAL

FILLING IN CESSPOOLS, DRAINS, ETC.

The local authority outside London is empowered by Section 39 of the Public Health Act, to require the filling in or alteration of any cesspool, drain, ashpit or other necessary appliance which is prejudicial to health or a nuisance.
There is a right of appeal to a Court of Summary Jurisdiction.
In London, Section 83 of the Public Health (London) Act, 1936, confers broadly similar powers upon the metropolitan borough councils, the right of appeal, however, being to the L.C.C. and not to a court.

CESSPOOLS

Both in London and in the Provinces the situation and construction of cesspools are dealt with by byelaws of the L.C.C. and of local authorities respectively.

SEPTIC TANKS
LEGAL CONSIDERATIONS

Septic Tanks are, by express definition in Section 90 of the Public Health Act, 1936, declared (outside London) to be cesspools. They must, therefore, be so constructed as to comply with the same restrictions as those applying to cesspools. The quality of the effluent is governed by the requirements of the various River Authorities (such as the Thames Conservancy Board) and by certain local authorities. Land Drainage Authorities, whether Catchment Boards or subsidiary authorities, have no powers under the general law (Land Drainage Act, 1930) regarding publicly or privately owned sewage disposal plants, either as to their provision and design or as to the effect of their effluents upon the rivers and watercourses into which they discharge. Powers with regard to river pollution are, generally speaking, exercised by County Councils or by Joint River Boards or Rivers Committees, acting under the Rivers Pollution Prevention Acts, 1876 to 1893, though every local sanitary authority is competent to take procedure under those enactments. The Thames Conservancy Board and the Lee Conservancy Board, however, possess both the powers of catchment boards and also the powers of rivers pollution prevention authorities, the latter powers under special parliamentary enactments.
The standard to which any sewage effluent should comply before being discharged into a river, directly or by means of subsidiary streams or ditches, etc., is contained in one of the reports issued by the Royal Commission on Sewage Disposal. The standard suggested was that a normal sewage effluent should not contain more than 3 grams per 10,000 of suspended matter and should not take up more than 2 grams of dissolved oxygen per 100,000 at 65° F. in 5 days. Cases are experienced where the relatively small volume of the effluent receiver makes a more stringent standard necessary, and, on the other hand, where dilution is such as to allow some relaxation. The determination of suspended matter and the oxygen absorption are complicated processes and could not be carried out by an architect; but it is a simple matter to have tests taken. An approximate test is to fill a wide-mouthed flask with the effluent in question and stopper tightly. After 24 to 36 hours, shake the bottle and allow the contents to settle for a few minutes. If there is a complete absence of recognisable smell, the effluent can be considered reasonably safe and non-putrescrible.
Section 50 of the Public Health Act, 1936, which (outside London) makes it an offence to allow the contents of any cesspool (including any sewage tank) to overflow, containing an express exception for effluent for a proper tank, if the effluent is itself not prejudicial to health or a nuisance.
In London the relevant Acts do not refer to anything of this sort except cesspools. It is apprehended that a septic tank, if constructed in London, would have to comply with the L.C.C. byelaws with respect to cesspools.

GENERAL DESCRIPTION

A Septic Tank is a chamber in which sewage matter is prepared for the final stage of purification (oxidisation) either in a filter bed or in the subsoil. The sewage is retained in the chamber for a period in order that it may become septic, i.e., swarming with anaerobic bacteria which break up the organic matter into simple chemical compounds and convert it into a liquid or a gas. As the main function of the tank is to liquify the solid organic matter, it is essential that the sewage be retained for a minimum period of twelve hours, although 24 hours is better. The partially purified sewage which leaves the tank may be discharged over a filter bed or, where the soil is of an ideal porous loamy nature, taken directly through unglazed distribution pipes into the subsoil at a depth generally not exceeding 18″. The combined use of the filter bed and field pipes is often necessary. It is in this filtering process that the final purification occurs by means of aerobic bacteria which form colonies in the filter bed usually at a depth of 2″ to 4″ under the top layer of filtering material, or are to be found in the subsoil at a depth usually not greater than about 18″. Below 4′ the subsoil has practically no purifying effect. It should be noted that the filter bed must not be flooded, but should have an outlet at the bottom, and the effluent made to percolate from the top through the filtering material. The filter bed is always desirable, but it becomes a necessity where the ground space is limited or where the final effluent is discharged into a ditch or stream.

DESIGN OF SEPTIC TANK

While tanks of almost every size and shape are in use, recent investigation seems to favour the long narrow shape having a minimum depth of 4′ and a minimum capacity of 200 gallons. Every installation must be carefully considered in respect to the particular conditions. Appendix K of the Ministry of Health "Housing Manual" affords authoritative guidance as to general design.

Construction

The tank should be watertight, and the walls constructed accordingly. The walls may be of 9″ brickwork in cement mortar, with a 6″ concrete floor and a light reinforced concrete cover laid in sections suitable for lifting. Where concrete is used throughout, the walls should not be less than 4″ thick, and the floor 6″ thick.
The above construction does not apply to free-standing tanks, or where it is necessary to resist an external water pressure, and each case must be considered in relation to the actual site conditions.

Size

This may be computed on the basis of 100 gallons per day from a normal small house and a tank capacity of 12 to 24 hours flow is recommended according to the tank size. The following table gives sizes suggested by the *Housing Manual* :—

Number of houses	Hours flow	Tank Capacity Gals.	Depth ft. in.	Length ft. in.	Width ft. in.
2	24	200	4 0	4 0	2 0
4	20	333	4 3	5 0	2 6
6	18	450	4 0	6 0	3 0
12	15	750	4 6	8 0	3 4
20	12	1000	5 0	8 0	4 0

For 20 houses two tanks in parallel might be substituted. Tanks should be covered and have bottoms sloped towards the inlet to facilitate removal of sludge.

Filter Beds

The size may be estimated on the basis of one cu. yd. for every 45 gallons of flow with a minimum depth of 2′ 6″ or a maximum of 5′. The ideal material is furnace clinker, although slag, broken stone or gravel may be used, but require a greater surface area. The material is graded from about 2″ stuff on the top to $\frac{1}{2}$″ in the middle, thereafter increasing to 2″ or 3″ stuff at the bottom of the bed. The filter bed may have a concrete floor, which must be inclined in the direction of the flow and upon which perforated bricks should be laid immediately below the filtering material. The effluent is discharged over the filter bed by means of a tipper or syphon leading to a series of perforated channels. After percolating through the bed and the perforated bricks, it is collected in a channel or humus chamber for delivery to the main outlet pipe communicating either with a ditch or stream, or system of distributing field pipes. Where no land treatment is available, the filter should have an area sufficient to deal with 40 gallons per sq. yd. per day for a bed 2′ 6″ deep or at a proportionately greater rate for a deeper filter.

Field Pipes

The length of field pipes required depends on the nature of the soil and may vary from 25′ to 50′ per person. These are laid to a fall of about $\frac{1}{2}$″ to 1″ in 10′ with butted joints.

Ventilation

A vent pipe is usually provided to the tank for the purpose of carrying off any accumulation of gases. This is in addition to the fresh air inlet to the drain.

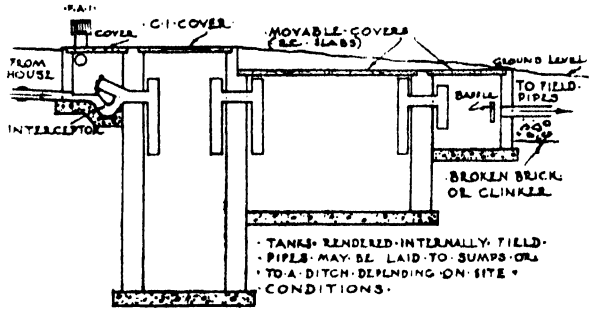
Intercepting Trap

The use of an interceptor between the house drainage and the tank is not considered essential by some authorities who maintain that it fulfils no useful purpose and may cause stoppages ; but though many local byelaws do not require a trap where drains empty into a sewer, they usually insist upon one where drains empty into a cesspool or other place (not being a sewer) for the reception of drainage.

The following sketches illustrate types of septic tanks used with success in this country and in the Colonies :—

TYPE No. 1

Shows a deep disintegrating chamber with a long narrow septic tank and a simple small distributing chamber at the outlet and having a wooden baffle opposite the outlet to prevent the egress of any solid matter.



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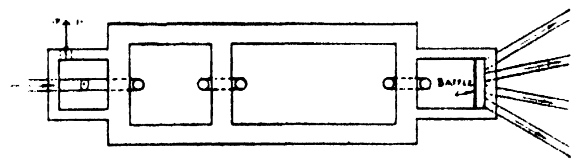
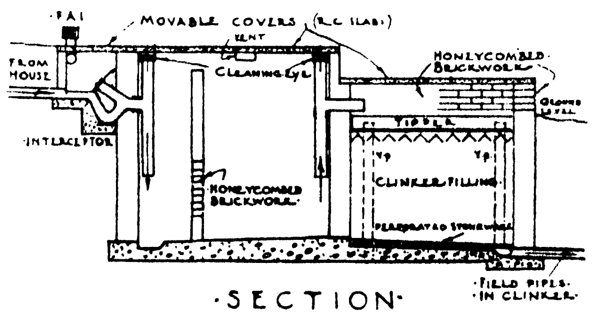


PLAN

TYPE No 1.

TYPE No. 2

Shows the tank with a disintegrating chamber formed by a honeycomb partition wall (which is often omitted) and a filter bed with the overhead tipper and the outlet at the lowest point below the clinker filling.



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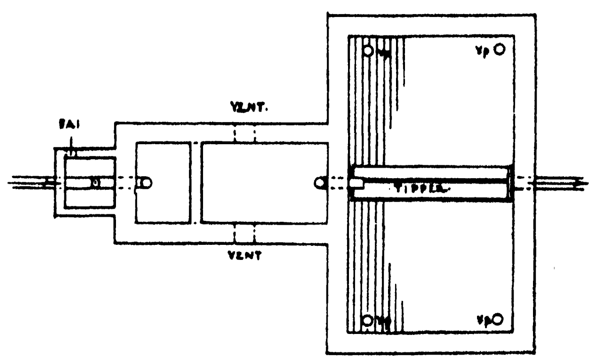
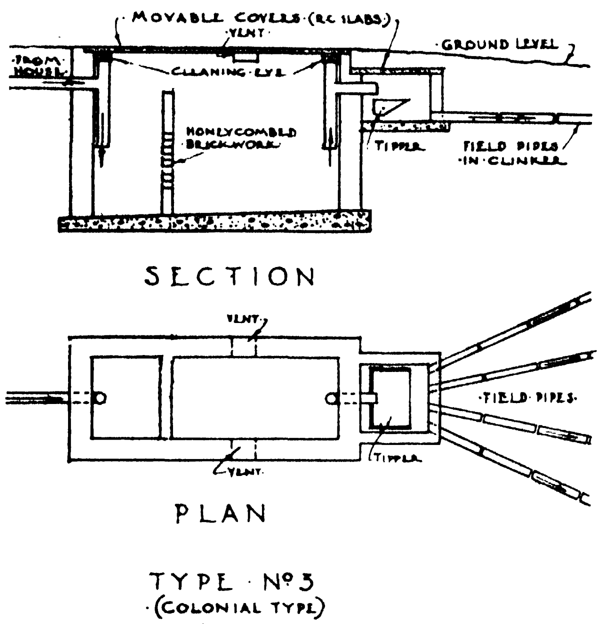


PLAN

TYPE No 2.

TYPE No. 3

Shows a similar arrangement as No. 1 but without the deep disintegrating chamber.



SYPHON OUTLETS

In all the above types a small syphon fitted in the outlet chamber (in case of Type No. 2 a small chamber would be added) gives the advantage of a periodical full flush to the outlet pipes and field drains. This prevents the possibility of the pipe lengths nearest the outlet chamber being choked up gradually by sediment from slowly flowing sewage effluent, as well as ensuring better distribution of the effluent to the field pipes.

A typical layout incorporating syphon dosage for the filter bed and suitable for a medium-sized country house is illustrated on the following page. The addition of a small humus chamber should be noted.

SEDIMENTATION TANKS

Where the daily volume of sewage is considerable (at least 100 persons) sedimentation tanks are preferable to septic tanks. The sewage is not allowed to become septic in a sedimentation system, but should pass through in about 4 to 12 hours, during which time most of the suspended solids will have settled to the bottom to form sludge. To facilitate the removal of this sludge at certain intervals the bottom of the tank should slope at least 1 in 10 towards the inlet end. The remaining liquid sewage flows into a dosing chamber from where it is periodically discharged by means of sprinkler pipes over a filter bed through which it percolates and is then allowed to run into a stream or ditch or to soak into the ground from field pipes. Unless supervision is available, this system is not recommended, but for schools, institutions, camps and hostels, sedimentation tanks under conditions favourable to their use, will give satisfaction.

DESIGN OF SEDIMENTATION TANKS

The design of sewage disposal works incorporating sedimentation is a matter for the sanitary engineer, and expert advice should be sought.

CHEMICAL CLOSETS

A chemical method of sewage disposal is often the most convenient one in unsewered districts, or where water supply is not laid on, or where it may be limited. The general principle of the method of disposal is the provision of a non-corrosive tank in which a suitable liquid chemical acts upon the sewage, disintegrating paper and other solid matter and rendering the whole sewage sterile and odourless. To facilitate the action of the chemical an "agitator" device is often provided inside the tank, which stirs up the whole contents and is easily operated by light pressure on a handle placed near the seat of the closet. In recent types there is an anti-splash device which forms part of the agitator. A ventilating pipe is attached to the back, and carried up either inside or outside the building in a manner similar to any other soil ventilating pipe.

Outside London, a chemical closet was a "privy" within the meaning of the Public Health Acts, earlier than 1936. The Public Health Act, 1936, declares it (strange to say), to be an earth closet. The most important practical result is that it cannot, under the new law any more than the old, be constructed inside a house, but must have an entrance from the external air.

In London, the Public Health Acts do not mention chemical closets, nor contain definitions similar to those of the older provincial law. It is apprehended that a chemical closet (if installed in London) would have to comply with the L.C.C. byelaws with respect to privies.

In most of the chemical disposal systems caustic soda, phenol and creosote are used for sterilizing and deodorising. The strong corrosive action of caustic soda, however, makes it necessary to handle the recharging fluid with special care, owing to danger from burns, besides making it necessary to place the soakaway some distance from a well or other source of water supply. Care should also be taken to see that where a caustic soda type of sterilizing agent is used, the soakaway is not near any flower-beds, shrubs, trees or lawns.

References

Ministry of Health "Housing Manual," 1946. Technical Appendix K.

G. E. Mitchell, "Sanitation, Drainage, and Water Supply." (Newnes). 1946. 10s. 6d.

G. M. Flood, "Sewage Disposal from Isolated Buildings." (Sutherland). 1923. 12s. 0d.

SHOP FRONTS

L.C.C. BYELAW 142

No part of any shop front shall be fixed higher than 25′ above the level of the ground immediately in front of the shop, nor be fixed nearer to the centre of a party wall or to the external wall of the adjoining premises than 4″, or where the shop front projects, nearer than the amount of the projection, unless separated by a pier or corbel 4′ wide between the centre of the party wall and the shop front.

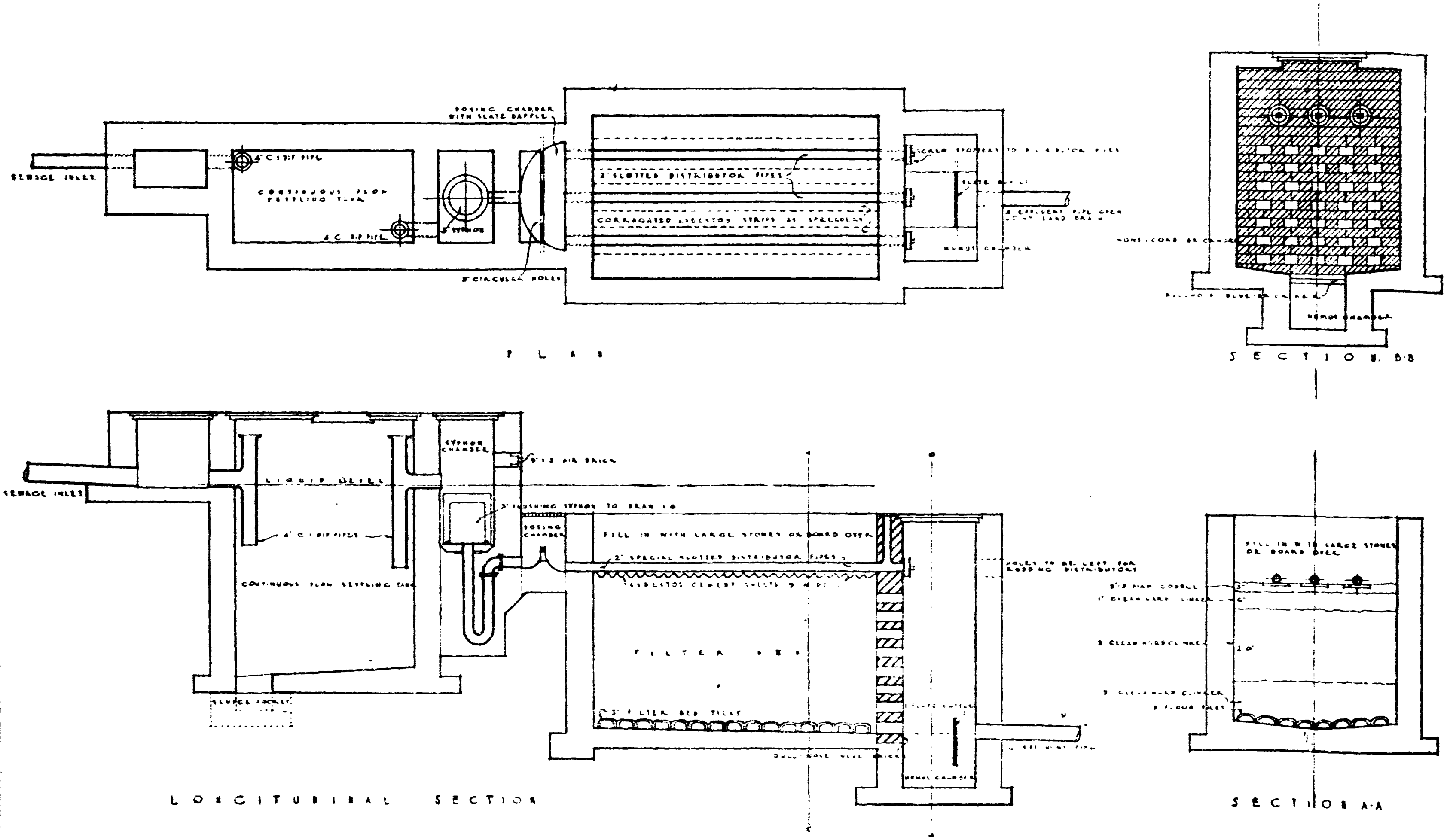
SINKS

(See also B.S. 1206, 1229 and 1244.)

Sinks for ordinary domestic use are generally fixed at a height of 2′ from the floor to the underside of the sink. This should be regarded as a minimum. For deep sinks 8″ or over in depth, 2′ 10″ from floor level to the top of the sink is the usual height.

The following Table gives the overall sizes of sinks usually stocked. In small domestic work the size most commonly used is 24″ × 18″ × 10″ overall.

SEWAGE DISPOSAL PLANT FOR COUNTRY HOUSE
TYPICAL LAY-OUT.



SIZE OF SINKS—DIMENSIONS GIVEN IN INCHES

Belfast pattern		London pattern	
24″ × 16″ × 7″	30″ × 18″ × 10″	18″ × 14″ × 5″	30″ × 20″ × 6″
24″ × 18″ × 7″	30″ × 20″ × 10″	20″ × 15″ × 5″	32″ × 20″ × 6″
27″ × 18″ × 7″	32″ × 18″ × 10″*	24″ × 16″ × 5″	36″ × 18″ × 6″
30″ × 18″ × 7″	36″ × 18″ × 10″	24″ × 18″ × 5″	36″ × 20″ × 6″
36″ × 20″ × 7″	36″ × 20″ × 10″	27″ × 18″ × 5″	36″ × 24″ × 6″
24″ × 16″ × 10″	36″ × 24″ × 10″	30″ × 18″ × 5″	42″ × 24″ × 6″
24″ × 18″ × 10″*	42″ × 24″ × 10″	30″ × 18″ × 6″	48″ × 24″ × 6″
27″ × 18″ × 10″	48″ × 24″ × 10″		

For laboratory, kitchen equipment, housemaids' and other special sinks, see makers' catalogues.

*Note.—British Standard Sizes.

SITES OF BUILDINGS

(See also " New Buildings." p. 95.)

COVERING-IN OF WATERCOURSES AND DITCHES

Outside London, Section 262 of the Public Health Act, 1936 entitles the local authority, where they deem it necessary, to require the owner of any land to fill up, or pipe any water course or ditch which need not actually be under the proposed building before beginning any building operations. By Section 263 such work may not be done until after the submission to and approval of plans by the local authority. Any dispute as to the necessity or nature of the work to be carried out, shall be settled by a Petty Sessional court on application by either party. Any such works must by Section 264 be cleansed and repaired by the owner when so required.

BUILDING OVER CHUTES AND TIPS

Section 54 of the Public Health Act, 1936, prohibits the erection of any building over ground impregnated with faecal or offensive animal or vegetable matter unless the local authority are satisfied that the material has become innocuous.

DEPOSITS OF MATERIAL CAUSING DAMPNESS, ETC.

Under Section 92 of the Public Health Act, 1936, any deposit of material on any land which gives rise to damp in any building or is otherwise prejudicial to health can be dealt with by summary proceedings as a nuisance.

There are broadly parallel provisions in force in London.

SLATES AND SLATING

North Wales.—Produces grey, purple and green rock which can be split into thin slates with a smooth surface.

South Wales.—Produces grey or grey green rock which does not split so thinly or so smoothly as that of North Wales.

Cornwall.—Produces grey and green slates sometimes with a rustic red or brown staining, with a fairly smooth but irregular surface, and of medium thickness.

Lake District.—Produces green slate of various shades, also a dark neutral grey slate. These varieties have a rough texture and are thicker than any of the above.

Yorkshire.—Produces grey and brown heavy roofing and paving slabs from the sandstone measures.

Horsham District.—Produces a rough warm-grey slab used for roofing and paving, from certain fossil beds of wealden series known locally as " Healing Stones." These are now difficult to obtain.

The Cotswold Area.—Produces a grey rough stone slab in small quantities known as Stonesfield or Collyweston slates which are obtained from the lower measures of the great Oolite.

Scotland.—Produces a nearly black slate with silver markings quarried in Argyle. The surface is smooth and the slate may be split nearly as thinly as that from North Wales. Grey and blue slate is also obtainable.

Norway.—Produces a thin smooth green slate and a rough-textured, rather thicker, silvery grey slate.

Important Note.—On specifying slating for use in industrial areas, care should be taken to select a slate which has successfully been used in the locality. (See B.R.S. Bulletin No. 12.)

Slates are sold by the " thousand " or mil of 1,200 except Westmorland slates, " Imperials," " Rags," and " Queens," which are sold by the ton.

The sizes of slates sometimes vary slightly according to the quarry, and are classified by names such as " Ladies," etc.

Cornish slate quarries supply a class of slate described as " random-width " in which the length (and accordingly the gauge) is even, but the slates are of varied width. These make an interesting surface when skilfully laid—less mechanical than with regular-sized slates.

Slates are classed according to their smoothness, straightness, fair, even thickness, etc., and are divided into first, second and sometimes third qualities.

For pitches of 45° and over, a 2½″ lap is sufficient.

For pitches under 45° a lap of 3″ is necessary.

If the pitch is less than 30°, the slates should not be less than 12″ wide.

The sizes in general use together with the gauge, allowing for a 3″ lap, for centre nailed slates, the number of squares that a mil will cover, allowing 5 per cent for waste, the number of slates required to cover one square (100 sq. ft.), the weight of slates nails and battens per sq. ft., and the size of nails, are shown in the following table :—

Type	Size in In.	Gauge for 3″ lap centre nailed	No. of squares covered by 1,200	No. of slates to cover 100 sq. ft.	Weight of slates nails and battens (lb. per sq. ft.)	Size of Nails
Doubles ...	12 × 8	4½	2·8	430	6	1⅜
Doubles ...	13 × 6	5	2·5	480	6	1⅜
Ladies ...	14 × 12	5½	5	240	6¼	1½
Ladies ...	16 × 8	6½	4	300	5½	1½
Viscountess	18 × 10	7½	6	200	6½	1⅝
Countess ...	20 × 10	8½	7	171	5¾	1⅝
Marchioness	22 × 12	9½	9½	130	5¼	1¾
Duchess ...	24 × 12	10½	10	125	5½	1¾

The thickness of Welsh slates is somewhat as follows :—

	First quality	Second quality
Duchess and Marchioness ...	3/16″	3/11″
Countess and Large Ladies ...	1/6″	¼″
Doubles	3/20″	3/13″

B.S. 680 : 1944 covers slates from most of the well known formations, and lays down standard designations, thickness gradings and marketing descriptions. In addition tests appropriate to various atmospheric conditions are specified. Standard lengths only are prescribed in the widths most commonly produced.

BATTENS

The size of battens is usually 1½″ to 2″ × 1″, but the thickness may be reduced when battening on boarding. Ordinary sawn plasterer's laths are sufficient for counterlathing.

NAILS AND NAILING

Slates are often holed for nailing 1″ to 1½″ from the head, but they are better centre holed. Head nailing is not so strong as centre nailing because, should the wind get under the tail of the slate, it exerts a greater leverage on the nail and the slates are, therefore, more likely to be blown off

the roof. The only advantage gained by head nailing is the extra cover to the nails, but this is not important.

The best nails to use are copper, as they are less liable to corrosion. Composition nails, composed of an alloy of zinc, tin, and copper, are also expensive, but are tougher and less likely to bend than copper, and are often preferred on that account. Zinc nails are soft, not durable, and their heads are liable to come off ; they should not be used except in the cheapest work.

	Number per pound		
	1¼″	1½″	2″
Composition ...	164	144	96
Copper	190	145	90
Zinc	280	220	90

Zinc nails composed of 90 per cent spelter and 1 per cent lead.

Copper nails composed of 99·5 per cent copper and 0·5 per cent impurity.

Composition nails, composed of 60 per cent copper, 39 per cent zinc and 1 per cent tin.

It may be noted that the additional cost of using composition or copper nails instead of zinc is negligible on an ordinary job, and that the cost of scaffolding to replace a few slates may be a much more serious matter.

SLATE SLABS

Thickness	½″	¾″	1″	1¼″	1½″	2″
Weight in lb. per sq. ft.	7½	11¼	15	18¾	22¾	30
Approximate No. super ft. in 1 ton ...	300	200	150	120	100	75

Slate may be used for paving, fireplace surrounds, curbs, shelving, tables, switch boards, wall linings and decorative work. Where slate is employed with marble or other stone to form a diaper paving, care should be taken to see that the stone is of equal hardness to the slate.

References

P.W.B.S. No. 18 " Architectural Use of Building Materials." (H.M.S.O.). 1946. 2s. 6d.

J. Miller, " Slating and Tiling." (English Universities Press). 1937. 5s. 0d.

SPRINKLERS—AUTOMATIC

Automatic Sprinkler Installations are intended for the protection of the interior of premises against fire. Where the nature of the business carried on, or the materials handled or stored, constitutes a risk greater than normal, a reduction in the insurance premium rates is obtainable if sprinklers are installed.

Sprinkler installations must be arranged strictly in accordance with the Rules of the Fire Offices' Committee if the appropriate premium reductions are to be claimed. These rebates vary from 25 per cent to 70 per cent according to the nature of the risk. Sprinklers are essentially thermotats, each head being constructed on the fusible link principle, fusing at a predetermined temperature and allowing a stream of water to play on the fire, simultaneously ringing an alarm bell.

Sprinklers may be arranged as " wet-pipe," " dry-pipe," or " wet-and-dry-pipe " systems. In the " wet-pipe " system the pipes are continuously filled with water under pressure and the opening of a head allows the water to flow. In the " dry-pipe " system, usually installed in unheated buildings or situations where there is a risk of frost affecting water in pipes, the latter are filled with air under pressure sufficient to keep the water supply valve closed, but the opening of a sprinkler head relieves this pressure and allows the water to enter the pipes. The piping of such a system must be very carefully graded to allow of complete drainage after each filling with water, the minimum fall being about ½″ in 10′. The " wet-and-dry-pipe " system is a combination of the foregoing, the dry-pipe portions being those subject to the risk of damage due to frost.

The Rules governing the installation of sprinklers have been very carefully and elaborately framed and should be consulted in detail for each case, and the advice of a specialist, or the Insurance Office covering the risk, obtained in confirmation. The spacing of heads for most purposes is on the basis of one to each 100 sq. ft. of area, but certain definite limits are in force regulating the maximum distances between heads, from heads to walls, heads to deep beams and other obstructions.

Installations are classified, according to the water supply available into three general types, viz. :—" Standard," " Ordinary " and " Single Supply." The requirements and alternatives for each class are clearly set out in the Rules.

For external protection, in cases where there is considerable risk of fire spreading from an adjacent building to a sprinklered building, external drenchers or water curtains are used to protect openings, roofs, etc. While sprinklers are automatic in operation, drenchers are usually hand-operated.

Installations must be carefully maintained in good order and tested at regular intervals, including the alarm bell. The latter is a most important part of the plant, as it draws attention to the fact that a head has opened, whether through the effects of fire or by accident.

STAIRCASES

B.S. 585 : 1944 standardizes wooden stairs for domestic use. The rule given below for relation of rise to going is adopted.

TREADS AND RISERS

Treads vary from 8″ to 13″ and risers from 5″ to 8″. Proportions should not vary between floors. The standard rule for ascertaining the proportion of treads and risers is twice the rise plus the tread equals 23.

The treads and risers should be :—

	Treads Not less than	Risers Not more than
For schools	11″	5½″ to 6″
For factories	10″	7½″
For theatres	11″	6″

In dwelling-houses 10″ × 6½″, and in public buildings 11″ × 6″ or 12″ × 5½″ are suitable dimensions.

In local authority housing the Ministry of Health " Housing Manual " recommends that risers be not greater than 7½″, with a " going " of not less than 8½″.

HANDRAIL

The height to the top of the handrail should be 2′ 6″ to 2′ 10″ above the tread, measured vertically in line with the riser. At the landings the height should be about 3′. Staircases with deep wells should have the handrail placed higher than in normal cases.

DOMESTIC CONSTRUCTION

The British Standard sizes of the various parts in domestic staircases are :—Treads, 1″ ; Risers, ¾″ ; Wall strings, 1¼″ ; Outer strings, 1½″. Wooden staircases, when uncarpeted, should have treads of greater thickness than usual in order to minimise the noise of traffic : in this connection the solid wooden tread is ideal.

STAIRCASES, PASSAGES, ETC. (FIRE-PRECAUTIONS)

(See also " Fire Escapes," p. 63.)

In London, Section 25 of the London Building Acts Amendment Act, 1939, requires that in every public building the floors of lobbies, corridors, passages and landings and the flghts of stairs, shall be constructed of, and carried by, supports possessing, such degree of fire-resistance as the L.C.C. determine.

The L.C.C. issues a list of materials and constructions which they have determined to be fire-resisting for this purpose.

Sections 34 and 35 of the same Act empowers the L.C.C. to require means of escape from most other types of building, whether new or old, except the smaller dwelling houses. These requirements will, subject to the limitations in the Act itself, be decided on the merits of each case. There is a right of appeal to the Tribunal of Appeal under Sections 34 and 35, but not under Section 25.

CONSTRUCTION OF FLOORS, STAIRS, ETC., IN BUILDINGS WITH DIFFERENT TENANCIES.

In every building exceeding 25 squares in area, or exceeding a cubic content of 125,000 cu. ft. which is constructed to be tenanted by different persons. L.C.C. Byelaw 140 requires that :—

(a) (i) The whole of the floors : and

(ii) All lobbies, corridors, passages, landings and stairs used in common shall be of fire-resisting materials, and enclosed with terra cotta, brick or concrete or other incombustible material at least 3″ thick : any doors and door frames to such enclosure to be fire-resisting.

Outside London, several of the larger local authorities have comparable powers, differing from one town to another under local Acts of Parliament.

PLACES OF PUBLIC ENTERTAINMENT AND RESORT, MEANS OF INGRESS AND EGRESS.

Section 59 of the Public Health Act, 1936, empowers the local authority to require in certain buildings old as well as new means of ingress and egress for the public having regard to the user of the premises. Such means of ingress and egress must be kept unobstructed. There is a right of appeal to a Court of Summary Jurisdiction.

In addition, there may be local byelaws or local Acts in force, information as to which must be sought from the local authority. The use of certain buildings of this type may be subject to other provisions. For example, the use of a building for a cinematograph theatre is regulated by the Cinematograph Act, 1909.

Section 59 above mentioned applies to places of public worship, with certain exceptions, theatres, public halls, the larger shops, restaurants, etc., and certain clubs and schools.

STRUCTURAL INSULATION

See special article by A. C. Hutt, A.M.I.Mech.E., on p. 205.
See also Post-War Building Studies Nos. 1 and 15 for statements as to recommended standards of insulation for walls, floors, and roofs.

The following table of data on commonly-used insulating materials has been supplied by the Structural Insulation Association :—

Material	General Description	Weight lbs./cu. ft.	Thermal Conductivity in B.Th.U's/sq. ft./hour/ 1″ thickness/ 1°F. diff. in temperature	How Supplied	Standard Sizes	Standard Thicknesses
ALUMINIUM FOIL	(a) Aluminium Foil reinforced with Kraft paper (b) Plain and corrugated sheet combined	Negligible 12 oz.	0.23 (Conductance)* 0.21	Rolls Rolls	250′ × 2′ 50′ × 2′	— [illegible]″
ASBESTOS	Asbestos fibres loose or in block form	9 18 10	0.35 0.450—0.50 0.35	Bagged Boards Blocks	1 cwt. bags 6′ × 3′ max. 4′ × 3′ max.	— ½″ 1″ to 4″ × ½″s
COMPRESSED FELT	100 per cent animal hair compressed to form boards	11–12	0.27	Sheets	34″ × 20″	½″ to 1″
CORKBOARD	Granules of Cork baked under pressure to form slabs	7½–9	0.29	Slabs	36″ × 12″ and 36″ × 24″	1″, 1½″, 2″, 3″ & 4″
EEL GRASS (Cabot's Quilt)	Matting of cured eel grass stitched between two layers of Kraft paper	4–5	0.26	Rolls (quilt)	84′ × 3′ 42′ × 3′	[illegible]″, ½″ & ¾″ 1″
FIBRE BUILDING BOARD	Light rigid boards made from compressed wood or other vegetable fibre	18	0.35	Boards	Lengths 6′ to 14′ Widths 3′ & 4′	½″
FOAMED SLAG	Foamed Blast-furnace Slag (B.S.S.877/1939)	½″ to ⅛″—27/33 ⅛″ to dust—36/44 Concrete—45/120	Aggregate 0.83 Concrete 1.7—1.9	Loose aggregate for cast *in situ* work, or for light-weight concrete units	Granule sizes— ½″—⅛″ ⅛″—dust	Normal buildin block sizes o[r] cast *in situ* as required
GLASS SILK INSULATION	Flexible glass fibres formed into a quilt Do. Resin bonded Do. Bitumen bonded	5 3 3	0.22 0.23 0.23	Rolls (quilt) Pads Rolls	81′ × 3′ 40′ 6″ × 3′ up to 68″ × 42″ Lengths 30′, 37′ 6″ & 45′ Widths 33″, 36″, 42″, 45″ and 48″	¾″ & 1″ 1½″ 1″ to 4½″ × ½″ 1″
SLAG WOOL MINERAL WOOL	A fireproof flocculent material of mineral origin	12–14	0.30	Bagged (loose) Rolls (blanket) Sheets (wire) netted) Slabs (felted)	½″cwt. bags Length to order Max. width 3′ Sizes to order 36″ × 12″	— ½″ to 1½″ ½″ to 6″ 1″ to 4″
WOOD WOOL BUILDING SLAB	Wood Wool cemented by a mineral cementing agent	25–30	0.58	Slabs	6′ × 2′	1″ to 3″ × ½″

*Conductance = B.TH.U's/sq. ft./hour/1°F. diff. in temp. Air-to-Air through one sheet.

STRUCTURAL STEELWORK

Steel for structural purposes, manufactured and rolled in Great Britain, may be identified by the words "British Steel" embossed on each section. Foreign steel rolled to British sizes usually has the letters B.S., followed by the size in inches, embossed on each section.

All structural steel used in the construction of a building under the authority of the L.C.C. must comply with the British Standard Specification for structural steel.

In all cases where it is intended that British Steel be used, a clause should be inserted in the specification on the following lines :—(The steel supplied is to be manufactured and rolled in Great Britain and must comply in all respects with the current British Standard Specification for structural steel, Quality A.)

STEEL-FRAMED BUILDINGS IN THE PROVINCES

Outside London the local byelaws should be consulted. These will be found to contain provisions (based on the model byelaws issued by the Ministry of Health) dealing with loadings, durability, protection of steel work from fire, etc., etc., with particular reference to appropriate British Standard Specifications.

STEEL-FRAMED BUILDINGS IN LONDON

In London, the corresponding provisions will be found in the byelaws made by the L.C.C. under the London Building Acts Amendment Act, 1935.

COVER TO STEELWORK

The requirements under the L.C.C. Byelaws, 1938, and also the London Building Act, 1930, Third Schedule, are as follows :—

Members	L.C.C. Byelaw 68 (1938)	L. Building Act, 1930 (Schedule 3)
(1) Stanchions in external or party walls	Completely encased by 4" of brickwork, terra-cotta, concrete, stone, tiles or other suitable incombustible material. Casings to be executed in Portland Cement and bedded close to the steel	(1) *In External Walls* 4" of brickwork, terra-cotta, concrete, stone, tiles or other incombustible material
(2) Stanchions other than in external or party walls	2" of brickwork, etc. and 1" cover to all projecting rivet heads, cleats and the like	(2) *Other than External Walls.* 2" of brickwork, terra-cotta, concrete, metal lathing and plaster or cement, but 1" cover to top flanges of beams and 1" cover to underside of subsidiary joists
(3) Beams in external or party walls	4" of brickwork, etc., etc., but casings to the underside of beams and to the edges of flanges may be 2"	(3) Similar
(4) Beams other than in external or party walls	2" brickwork, etc., but casing on upper surface of top flange and on projecting portions may be 1"	(4) Similar to (2) above in this column
(5) Stanchions and beams in one-storey buildings not exceeding 25' in height	4" cover on stanchions and beams in external, and stanchions in chases in party walls—no cover needed elsewhere	Similar
(6) Stanchions and beams in buildings other than steel-framed structures	4" cover on stanchions in external and on stanchions in party walls and 2" elsewhere as in (1) and (4) above	No cover to steelwork required

PERMISSIBLE STRESSES

The stresses laid down by the L.C.C. (Building Byelaw No. 81) are as follows :

(*a*) *Parts in tension*

	Tons per sq. in.
On net section for axial stress or maximum inbeams	8
,, ,, Shop rivets for axial stress ...	5
,, ,, Field ,, ,,	4
,, ,, Bolts (not less than ¾" diameter)	5

(*b*) *For compression flanges of beams*

On gross section for extreme fibre of beams embedded in a concrete floor or otherwise laterally secured	8
Uncased beams where laterally unsupported length "L" is less than 20 times the width "b" of the compression flange	8

Uncased beams where "L" exceeds 20 times "b"

$$11{\cdot}0 - 0{\cdot}15\,\frac{L}{b}$$

For beams solidly cased the width "b" above is the width of the compression flange of the beam plus the lesser side concrete cover beyond the edge of the flange on one side only with a maximum of 4".

The ratio $\frac{L}{b}$ shall not exceed 50.

(*c*) *For parts in shear.*

	Tons per sq. in.
On the gross section of webs	5
On shop rivets and turned bolts of driving fit ...	6
Field rivets	5
Black bolts	4

Note.—Rivets and bolts in double shear to be taken as twice that allowed in single shear.

The webs of beams to be adequately stiff to prevent buckling.

(*d*) *For parts in Beaming.*

	Tons per sq. in.
On packings, seatings and the like	12
Shop rivets and turned bolts of driving fit ...	12
Field bolts	10
Black bolts	8

BRITISH STANDARDS

B.S. 449 : 1937 specifies requirements for loading of steel structures, working stresses, and rules for constructional details, rivetting, fabrication and site erection. Qualities of steel are stated with reference to the following Standards:—B.S. 15 : 1936. Mild structural steel. B. S. 548 : 1934. High tensile steel.

For fire protection steelwork should be encased to comply with B.S. 476 : 1932.

See also P.W.B.S. No. 7 "Steel Structures." (H.M.S.O.). 1944. 6d.

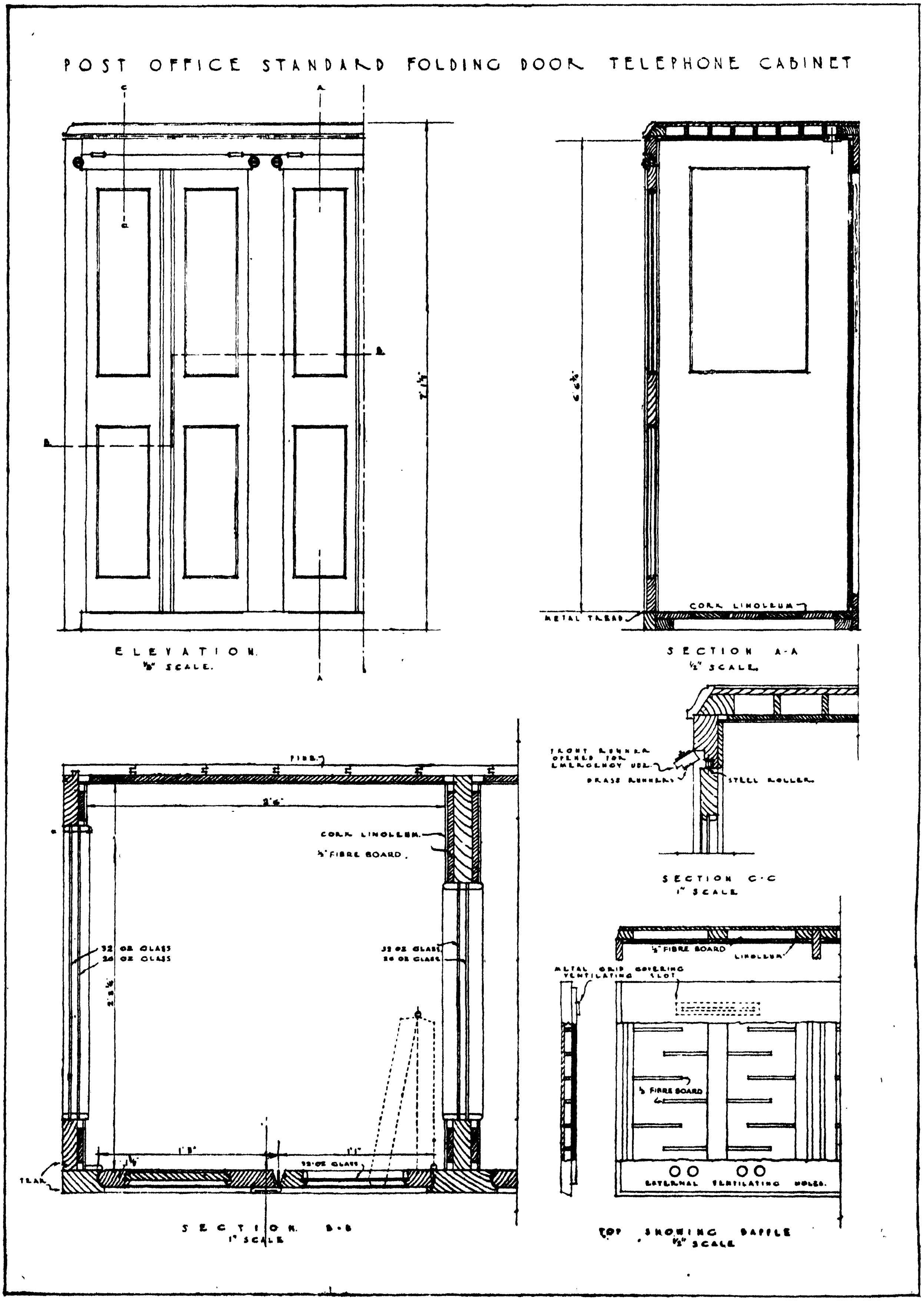
SURVEYING

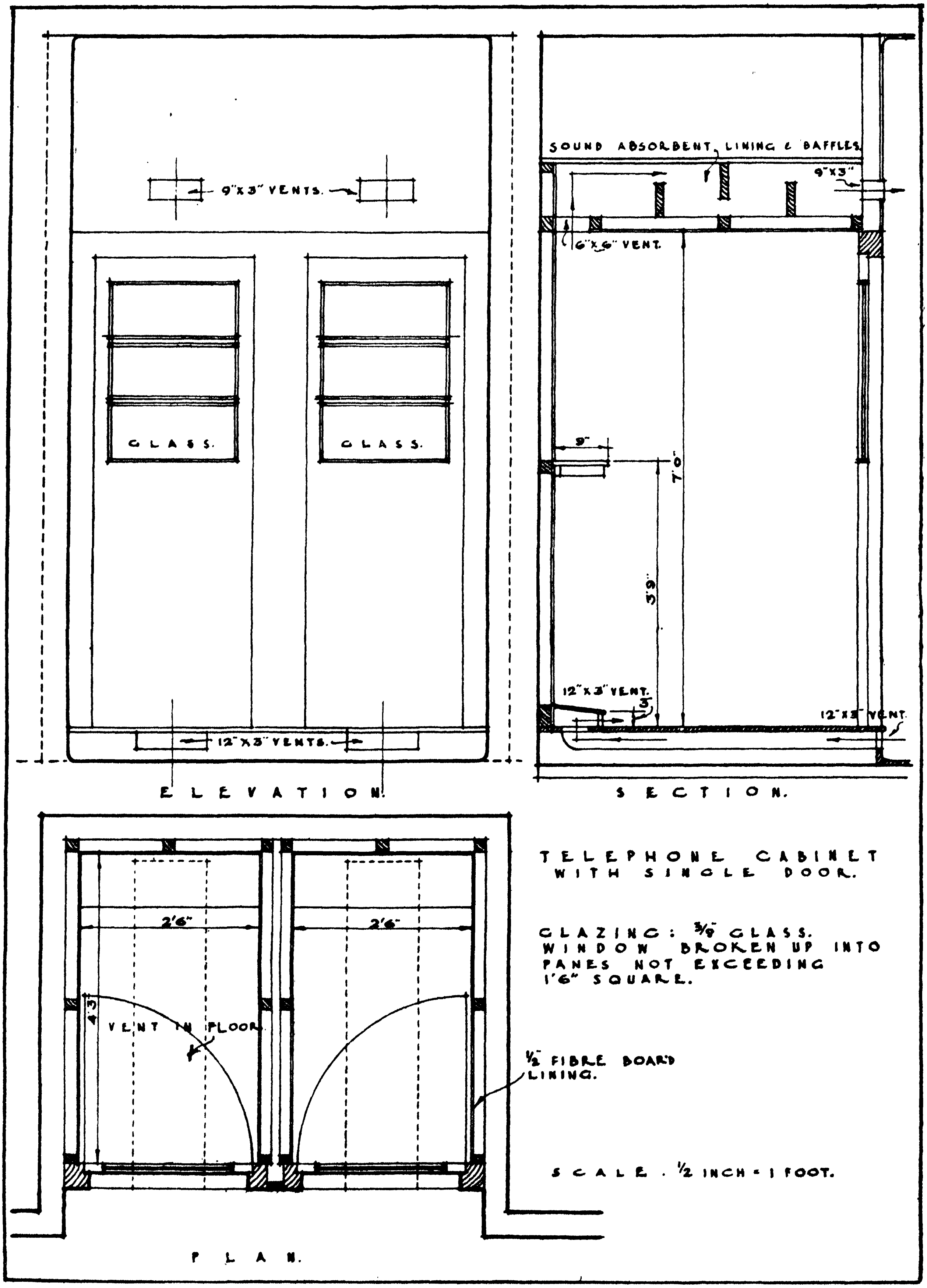
See under "Ordnance Survey Maps" p. 100.

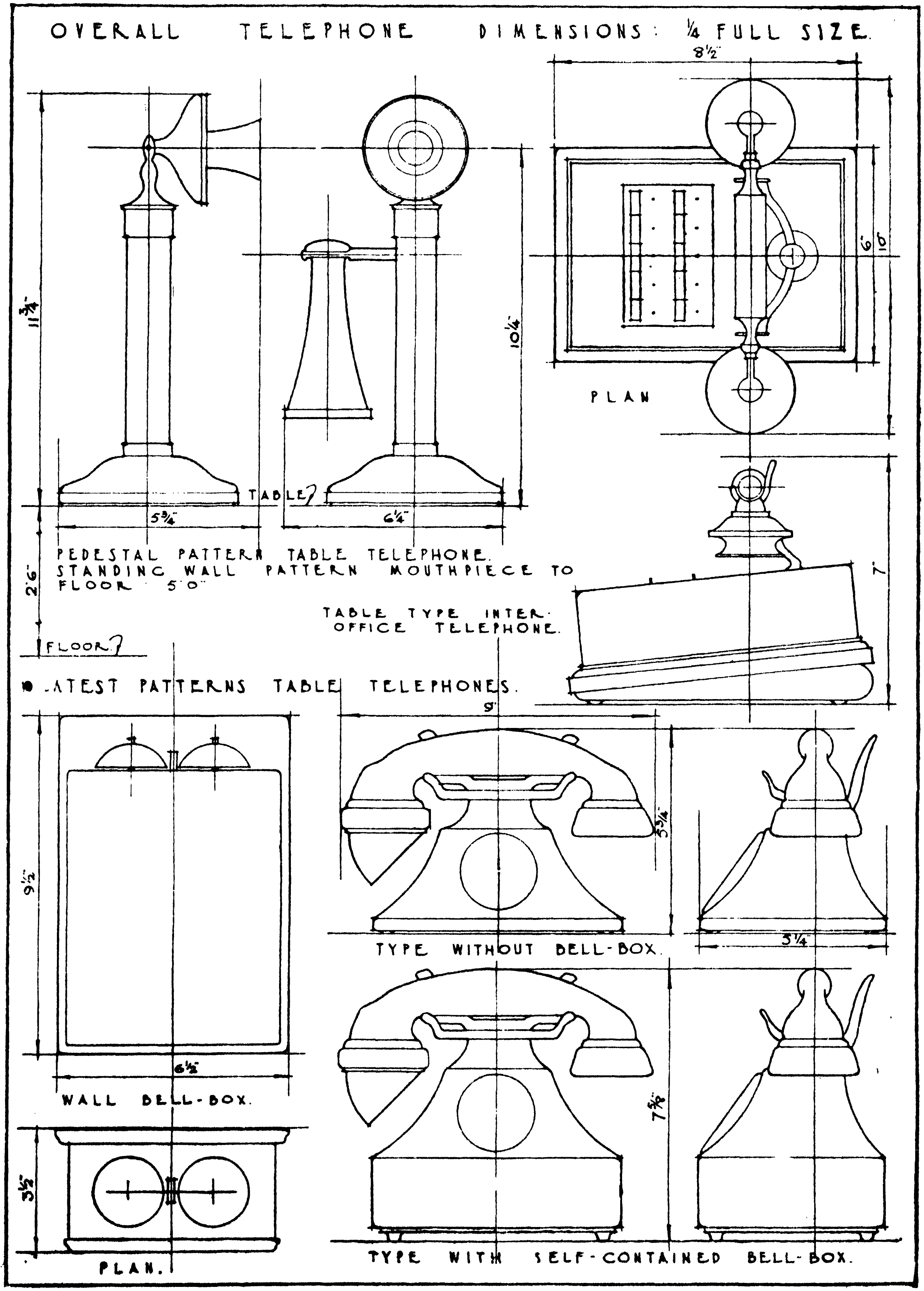
TELEPHONES AND TELEPHONE BOXES

The Post Office standard type of telephone box is shown on the following pages.

All telephone boxes must be ventilated, and special attention must be paid to non-transmission of sound.


POST OFFICE STANDARD FOLDING DOOR TELEPHONE CABINET
ELEVATION
SECTION A-A
½" SCALE
CORK LINOLEUM
METAL TREAD
SECTION C-C
1" SCALE
FRONT RUNNER OPENED FOR EMERGENCY USE
BRASS RUNNERS
STEEL ROLLER
FIBRE
2'6"
CORK LINOLEUM
½" FIBRE BOARD
32 OZ GLASS
26 OZ GLASS
TEAK
SECTION B-B
1" SCALE
½" FIBRE BOARD
LINOLEUM
METAL GRID COVERING VENTILATING SLOT
½" FIBRE BOARD
EXTERNAL VENTILATING HOLES
TOP SHOWING BAFFLE
½" SCALE


9"x3" VENTS.
GLASS.
GLASS.
12"x3" VENTS.
ELEVATION.
SOUND ABSORBENT LINING & BAFFLES.
9"x3"
6"x6" VENT.
9"
7'0"
3'9"
12"x3" VENT.
3"
12"x3" VENT.
SECTION.
2'6"
2'6"
4'3"
VENT IN FLOOR.
½" FIBRE BOARD LINING.
PLAN.
TELEPHONE CABINET WITH SINGLE DOOR.
GLAZING: 3/8" GLASS. WINDOW BROKEN UP INTO PANES NOT EXCEEDING 1'6" SQUARE.
SCALE. ½ INCH = 1 FOOT.


OVERALL TELEPHONE DIMENSIONS: ¼ FULL SIZE.
8½"
6"
10"
PLAN
11¾"
10¼"
TABLE
5¾"
6¼"
PEDESTAL PATTERN TABLE TELEPHONE.
STANDING WALL PATTERN MOUTHPIECE TO FLOOR 5'0"
2'6"
FLOOR
7"
TABLE TYPE INTER-OFFICE TELEPHONE.
LATEST PATTERNS TABLE TELEPHONES.
9"
9½"
5¾"
3¼"
TYPE WITHOUT BELL-BOX.
6½"
WALL BELL-BOX.
7⅝"
3½"
PLAN.
TYPE WITH SELF-CONTAINED BELL-BOX.

Telephone boxes for use in reporting and for running commentaries should be larger than the usual model. Particular attention should be given to the ventilation, owing to the long periods of occupation.

The following internal dimensions will serve as a guide in ordinary cases :—

	Width	Depth	Height
Minimum dimensions (door opening outwards)	2′ 4″	2′ 6″	7′ 0″
Minimum dimensions (sliding door folding to one side in two leaves, each 13″ wide)	3′ 0″	2′ 6″	7′ 0″
Minimum dimensions (door opening inwards)	2′ 6″	3′ 9″	7′ 0″
Street telephone boxes (London type in metal, door 2′ 2″ × 6′ 6″ opening outwards)	3′ 2″	3′ 2″	7′ 0″

The diagram on page 135 shows various types of telephones with the overall dimensions.

TEMPORARY BUILDINGS

In London, there are special provisions in Section 30 of the London Building Acts Amendment Act, 1939. Outside London some local authorities have special power under local Acts of Parliament to impose requirements additional to those of the ordinary law, but temporary buildings are not (as such) mentioned in the legal provisions which apply to building in most provincial areas.

THATCHED ROOFS

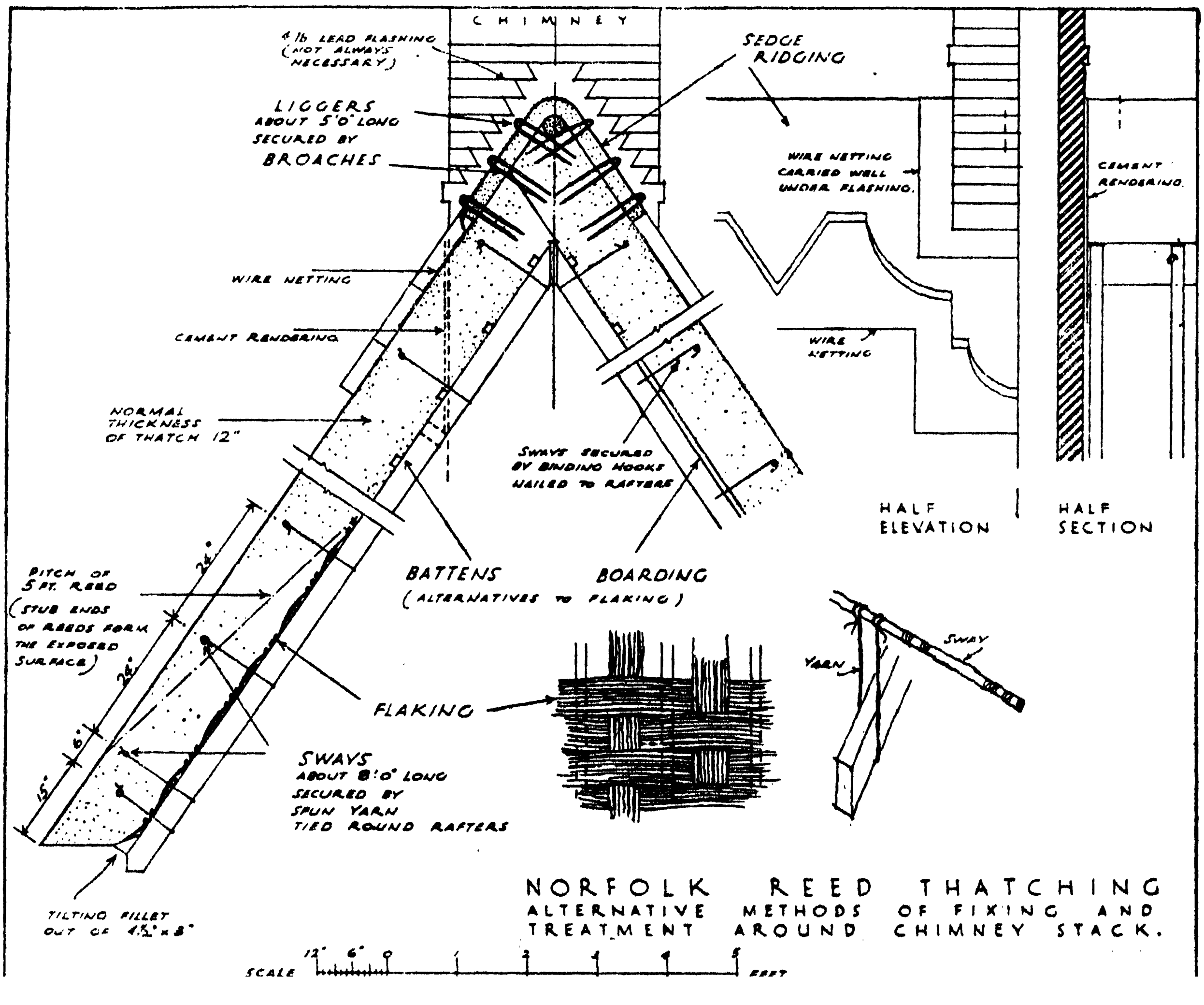
REED THATCHING

(See Sketch below.)

The true reed (*Arundo Phragmites*) is generally used and priced for "Best Reed" by Norfolk reed thatchers ; yet "Mixed Stuff," which consists chiefly of Best Reed with a growth of 10–20 per cent of the lesser reed mace (*Typha Angustifolia*) amongst it, is both cheaper and more durable. Best reed makes the neater job, the mixed stuff having a more mottled appearance.

Steep pitches up to 60° look best and weather best ; but a pitch of 45°—which should be the minimum for normal work—is quite commonly used, and even a lesser pitch can be satisfactory, though proportionately less durable. A specification for thatching should state whether best reed or mixed stuff is to be used, the thickness of work required (12″ is usual), and whether the roof will be battened or boarded above the rafters in any way which would dispense with the cost of the thatcher's flaking. Ridging designs are often left to the thatcher and the price varies according to the elaboration of design required.

Thatchers measure their work by the square, measured on the outer (upper) surface of the thatch ; the area will, therefore, be greater than for slating or tiling. Diagonally cut tilting fillets out of 4½″ × 3″ should be fixed at all eaves and verges. Lead flashings at the chimneys are not a necessity, and thatched roofs look better without them ; but if they



NORFOLK REED THATCHING
ALTERNATIVE METHODS OF FIXING AND TREATMENT AROUND CHIMNEY STACK.

are required, 4 lb. lead is quite sufficient, as it should be as pliable as possible to enable it to settle with the sedge without leaving a conspicuous gap. Oversailing courses in brickwork, however, serve the purpose better than flashings. Varying pitches of roof meeting at hip or valley are swept round by the thatcher almost as easily as if the whole roof were in one plane, resulting in a complete saving of valley gutters. In designing the roof, care should be taken to prevent rain on one part dripping to any large extent on to thatch beneath, as this in time will wear away the thatch and cause a conspicuous streak. Thatch coming up too near the cill of a dormer window, or where a window is situated just above a thatched porch, may be dangerous from the point of view of fire risk, as cigarette ends may be thrown out of the windows above. Chimney stacks should be rendered in cement where thatch butts up against them, though reed thatch is very much less inflammable than is generally supposed.

The roof will have to be flaked before thatching is commenced, unless suitable battens at 14″ centres, or boarding, have been fixed as a foundation to prevent the bulk of the reed laid parallel to the rafters from falling down between them. If the interior of the roof is to be exposed to view, flaking is more picturesque, the thin interlacements of reed giving an attractive appearance. Flaking may also act as an excellent key for plaster if such treatment is desired.

For added protection from wind and birds, the ridge (not the roof) should be covered with ¾″ galvanised wire netting, secured with galvanised wire pins 9″ in length thrust into the thatch. The ridging will last about 15 years and is easily repaired. When the reed roof shows sign of wear, local repair is simple ; but after about 75 years it may need half coating all over—which means adding about 9″ of new reed upon the existing roof, without having to strip the old thatch away. This can be repeated every second generation.

STRAW THATCHING

The customs in connexion with straw thatching are in the main similar to those for reed thatching. Wheat straw is used, and where it is available it is commonly held that straw thrashed by flail will give a longer life than that which is machine thrashed. Local patching and re-ridging will be required after about 10 years, and re-covering upon the old work after about 20 years. The cost is usually somewhat over 20 per cent less than that of reed thatch.

Various fire-proofing solutions have been advocated, but owing to the washing action of rain it appears necessary to renew these at least each year.

Thatching may also be done with heather, bent, and the bark peelings produced during the working of the poles for split chestnut pale fencing. Heather thatch is perhaps the longest lasting of all, but owing to the shortness and roughness of the material it is more likely to strip in exposed places. Where heather is used, it must be laid on 6″ of straw or sedge, or on boarding and felt.

FIRE PROTECTION

Corrugated asbestos sheets may be laid upon the rafters and under the battens before the thatch is applied, or the thatch may be treated with fire-proofing mixtures.

LEGAL PROVISIONS

Thatched roofs are, in London, illegal by reason of the L.C.C. Byelaws made under the London Building Acts Amendment Act, 1935. Outside London they will be found in most areas (if not in all) to be allowed by local byelaws based upon the model byelaws issued from the Ministry of Health, which contain special provision for thatched and similar roofs.

REFERENCES

Thatch. By C. G. Harper. *Journal of American Institute of Architects*. December, 1926.
Thatching. Special article in *Specification*, 1922.
Practical Building. July, 1928. Page 275.
Architects Journal. 26th April, 1933. Page 563.
Thatching. A Ministry of Agriculture Leaflet.
Fire Grading of Buildings (Post-War Building Studies, No. 20). Page 57.

TILES

FLOOR AND WALL TILES

QUARRY TILES

The term *quarry* is of considerable antiquity and was used in England from mediaeval times until the nineteenth century to denote any material—glass, stone or tile—in small squares. More recently its use has been limited to the coarsest type of ceramic flooring tile. The surface is not absolutely smooth, and supplies are only available in red, brown, buff, " blue " and certain intermediate colours. Sizes 6″ × 6″ × ½″ to ¾″, 9″ × 9, × 1, to 1¼, and 12″ × 12″ × 1¼″ to 2″. Sand faced quarries, which provide an excellent non-slip paving for external use, are made by certain firms.

B.S. 1286 : 1945 " Clay tiles for flooring." standardizes dimensions and workmanship.

VITREOUS TILES

These are also known as " admantine " tiles and " vitrified " floor tiles and are a finer type of the above available in almost any colour. Sizes 2″ × 2″, 3″ × 3″, 4″ × 4″, 6″ × 6″, 6″ × 3″, 6″ × 2″, 4″ × 3″, 4″ × 2″, and also in diagonal and straight halves to form patterns, in thicknesses from ¼″ to ½″.

GLASS TILES

Vitreous mosaic.—Partially refused cullet (broken glass) is made into flooring tiles, available in any size and colour. Thickness about ¼″ to ½″.

CONCRETE FLOOR TILES

The following are the standard sizes of precast concrete floor tiles from B.S. 1197 : 1944 :—

Size inches	Thickness inches
5 15/16 × 5 15/16	⅝
8 15/16 × 8 15/16	¾
11 15/16 × 11 15/16	1

Standard sizes of coved skirting and angles for use with the above tiles are also specified. The tiles may be coloured by the addition of pigments complying with B.S. 1014 : 1942.

ROOFING TILES

The standard size of clay roofing tile established by B.S. 402 : 1945 is 10½″ x 6½″ ; 11″ × 7″ is stated as an alternative, provided the tiles comply in other respects with the specification. The standard thickness is between ⅜″ and ⅝″ with a longitudinal camber of not less than half the thickness.

Tests for strength and water absorption are described, and a large range of " specials " is included in the specification.

Sizes of tile in common use before the establishment of a British Standard were :—

Type	No. per Square	1,000 Tiles will cover (Yds.)	Weight per Square in cwts.	Weight per 1,000 Tons Cwts.	Batten Gauge Approx. (ins.)	Size of Tile (ins.)	Approx. Battening per Square in ft. run
Plain Tiles (Broseley Machine-made) ...	480	20	11	1 1	3¾	10 × 6¼	300
Plain Tiles (Reading Hand-made) lap 2½"	480	20	13	1 4	3¾	10½ × 6½	300
Pan Tiles (Sand-faced)	170	66	7	2 0	10½	13½ × 9½	130
Somerset Interlocking	155	76	6¼	2 0	12¾	15¼ × 8	110
Single Roman	85	132	6	3 10	13⅜	16⅜ × 14	100
Do. (Smaller)	125	82	5	2 0	12	15 × 10	105
Double Roman	85	132	6	3 10	13½	16½ × 14	100
Interlocking Double Roman	85	132					
Spanish	220	50·5	13¾	3 2	Rafters at approx. 10" Centres	19½ × 7½–6	
"Abbey"	200	55	8	2 0		16" long	
Poole's	90	123	7½	4 0	13	16 × 14	100
Do. (Small)	150	74	7½	2 10	9½	12½ × 11	130
Cloister Interlocking	200	55	8	1 19	9¾	12 × 8¾	130
"D" and "G" Interlocking	147	75	7¼	2 9	11⅜	14¼ × 10¼	105
Marseilles	127	83	5¾	2 5	13⅜	16⅞ × 10	110
Priory	180	61	10	2 15	10	13 × 9½	130
Courtrai du Nord	205	53	6¼	1 10	9½	11¼ × 8½	130
Beauvais	195	57	7	1 16	9¾	12¼ × 8	130

Note.—The last six types in the Table are offoreign origin, but tiles of the Marseilles and Courtrai du Nord type are made in this country. Ridge tiles are usually made in 12" lengths. The usual sizes for battens are 1½" × ¾" for plain tiles and 2" × 1" for pantiles.

Ridge tiles are usually made in 12" lengths.
The usual sizes for battens are 1½" × ¾" for plain tiles and 2" × 1" for pantiles.

CONCRETE ROOFING TILES

The following British Standards should be consulted :—
B.S. 473 : 1944. "Concrete plain tiles and fittings."
B.S. 550 : 1945. "Concrete interlocking roofing tiles."

ABSORPTION

B.S. 402 demands that machine-made tiles should not absorb more than 10·5 per cent of their weight after immersion in water for 24 hours.

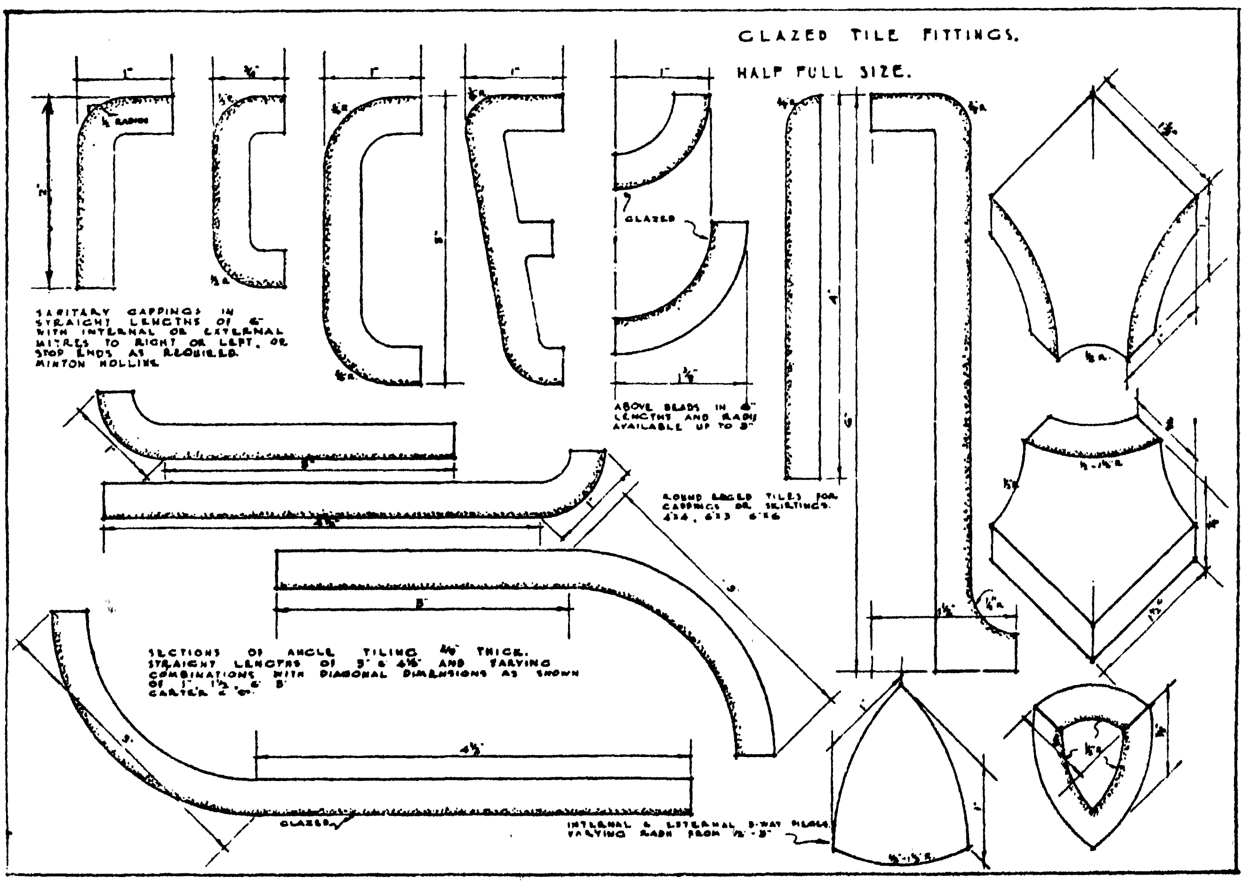
Hand-made sand-faced tiles may absorb as much ,as 16·5 per cent.

A so-called non-porous tile absorbs a certain amount of water which cannot evaporate quickly, and if it freezes there is a risk of flaking.

The nature of a hand-made sand-faced tile allows of more rapid evaporation of moisture, and as there is no "skin" on the tile there is much less risk of flaking or laminating.

WALL TILING

The diagram below shows some of the usual stock-size special tiles and fittings.



TIMBER

GENERAL NOTES ON TIMBER

The following notes have been supplied by the Forest Products Research Laboratory, Princes Risborough, Bucks :—

WHY KILN-DRYING HAS A BAD NAME

Some years ago there existed a very strong prejudice against kiln-dried timber, and although it has lessened very considerably in the meantime it still persists to some extent. It is understandable because it was based on report or experience of timber which had been damaged while in a kiln. There are no grounds for it whatever when a kiln is properly used.

The comparison is, of course, with air-dried timber, and the two processes of air and kiln-seasoning might be considered side by side. Actually, the same principles and factors apply to both. In both cases safe drying depends entirely on a reasonable balance being maintained between the rate of evaporation of moisture from the surface of the timber and the rate of internal moisture movement from the centre portions to the surface. The humidity of the air surrounding the wood controls the first while the temperature has a pronounced influence on the second factor.

In ordinary air drying both humidity and temperature are not directly controllable but depend on the climatic conditions. It so happens that in this country these conditions are generally, though by no means always, temperate, and timber dries satisfactorily enough. Timber can be spoiled in air-drying and, very frequently the accepted standard is perhaps lower than it need be.

In kiln-drying both temperature and humidity are under full control and can be regulated with proper regard to the known requirements of the timber. While this is so, it must be added that the kiln permits a wide range of conditions which if not controlled may cause damage greater than could possibly follow from exposure even to the most extreme vagaries of the weather.

" CONDITIONING "

A minimum movement from shrinkage and expansion can best be assured by carefully conditioning timber, i.e., drying it before manufacture to the moisture content most appropriate to its surroundings when in use.

Such a moisture content should be fixed as the mean of the range through which the timber will pass in the course of the seasonal changes of the year.

The conditioning can be done by kiln-seasoning, or by the subsequent drying of air-seasoned timber in a kiln, in a warm store, or even in the workrooms of the factory itself, before it is manufactured.

" RECONDITIONING "

Reconditioning is a term which has been given to a process of steaming timber after seasoning. The timber is warmed in a saturated atmosphere to a temperature of almost 212°F. which is then maintained for four to six hours according to the thickness of the wood. After allowing the timber to cool for a few hours in the kiln or steaming chamber it can be removed with safety.

The treatment is frequently effective in removing the excessive shrinkage due to collapse or other causes which may occur during seasoning, and in reducing the distortion which accompanies such shrinkages. It is thus a useful corrective of certain faults arising during the seasoning process. It is doubtful if, as is sometimes stated, it increases the stability of wood during subsequent use.

RATE OF GROWTH

Nearly all species of soft woods have lower strengths when grown very fast, the rate depending on the species, and again the timber is weaker when the rate of growth has slowed so that the rings are close together.

There is generally a broad optimum condition of growth, depending upon the species under consideration, but it may be taken for conifers that the best material will lie generally between the rates of growth of 6 rings to the inch and 24 rings to the inch.

Hardwoods are generally better when quickly grown and the range of optimum growth may be taken broadly as approximately 4½ rings to the inch to about 15 rings to the inch.

In timber for joinery purposes, where working qualities rather than strength are of primary importance, the slow-grown timbers, narrow ringed and with a low percentage of summerwood, are generally to be desired as they work more pleasantly under the tool.

In carcassing timbers such as joists, and rafters, the strength of each member when chosen from grades which allow the inclusion of knots, diagonal grain, splits and shakes, largely depends on the intensity and frequency of these defects, and upon their position relative to the important outside fibres over the more highly stressed portion either on the compression or tension faces.

End of F.P.R.L. Notes.

GRADING

For the best economic use of imported timber supplies the material should be graded according to whether it is to be used (*a*) for decorative purposes as in joinery, or (*b*) for strength as in structures. Much of the imported timber has been graded for its appearance, based on the presence of superficial marks and blemishes which frequently have little or no effect upon its strength. Timber to be used in structures and in positions where strength is the governing factor must be graded with reference to the size and frequency of knots and other defects that influence the strength, for economy is sacrificed when timber is used unsorted, as good timber in an unsorted parcel must enter the structure rated in strength with the lowest class of timber included.

The presence of knots in joists, rafters and other members of a structure is the chief source of weakness. The strength of a joist or other member supporting its load as a beam, depends upon size and position of the knot in the piece, thus a knot on the narrow face or edge has a greater weakening influence than one on the broad face near the centre line, and a knot near the middle of the span has a greater effect than the same size knot near the support.

Splits, checks and shakes may cause failure in longitudinal shear in a beam, and their sizes and numbers should be limited. Checks, however, have little effect upon the strength of a column or strut.

Softwoods (spruce, fir, etc.) when very quickly grown, are not as strong as the same timber grown at a normal rate for the species and for this reason grading rules frequently include clauses excluding those pieces which show, on the cross cut ends, less than a certain number of growth rings to the inch.

FACTORS OF SAFETY FOR TIMBER

The factor of safety to be applied to the ultimate stress in timber to obtain the safe working stress is not so simply obtained as that for a manufactured structural material such

as steel. For timber it is impossible to use the same factor of safety throughout for any one species, as the factor must be modified according to the grade of timber and the variation in size and frequency of defects between pieces within the grade. The factor of safety and safe working stress are directly related to the grade of a species of timber as defined by the grading rules (*q.v.*) which limit the maximum size of each of the defects that may occur in any one piece. Having established the description of the worst piece of timber that may occur in the grade, it is then possible from the results of mechanical tests to derive the appropriate factor of safety and the safe working stress for the grade.

In addition to the factors of safety for the particular species, a further factor must be applied when the timber is placed in a moist position where it may be attacked by fungus. This additional factor provides for the safety of the structure for a short time until it is reasonable to suppose the rot can be detected and the necessary repair made.

WORKING STRESSES FOR TIMBER

See B.S. 940, Part I : 1944, Part II : 1942. "Grading Rules for Stress-graded timber and structural timber."

See also Appendix E to the Ministry of Health Housing Manual : "The Scientific Use of Timber." This gives working stresses for various available timbers and recommended sizes for joists and rafters.

DEGREE OF SEASONING REQUIRED FOR VARIOUS PURPOSES

The chart on the page 141 shows the moisture content required in timber for various classes of work.

Strictly, the moisture content should be varied with the species, but only in exacting cases would the use of average figures given in the chart lead to trouble.

It cannot be expected in a commercial consignment that the moisture content will be exactly the same in every individual piece. The figures given in the chart are the required mean value for the consignment which might reasonably include individual pieces, the content of which varied by 2 per cent above or below the mean. Thus, timber having a range of moisture content of 9 per cent to 13 per cent with an average of 11 per cent would be suitable for centrally heated offices and block floors.

TIMBER PESTS

The following information on the Death-Watch Beetle, Common Furniture Beetle and Lyctus Powder-Post Beetle has been largely derived from publications by the Department of Scientific and Industrial Research (Forest Products Research Laboratory) and is published by permission of the Controller, H.M. Stationery Office. Those seeking advice on special cases should consult the Forest Products Research Laboratory, Princes Risborough, Bucks. (Telephone : Princes Risborough 101.)

THE DEATH-WATCH BEETLE

Description

The death-watch beetle (*Xestobium rufovillosum* De G.) derives its name from the tapping sound produced by the adults, audible during May and June, the mating period of the insects. The beetle measures from one-quarter of an inch to one-third of an inch in length. It is of a dark chocolate brown colour, but is coated with patches of short yellowish hairs which give it a variegated appearance.

Results of Infestation

It is believed that the life-cycle occupies from two to three years, or even longer. The beetles emerge in April, May or June and deposit their eggs in cracks, crevices, old exit holes or inside old tunnels in the wood. The larvae or grubs emerge from the eggs after a period varying from two to eight weeks and start to burrow in the timber for a period of twelve to twenty-four months or longer. It is during this stage in the development of the insect that the damage is done to the timber. After a chrysalis stage of two or three weeks, the adult beetle casts its pupal skin but remains in the pupal chamber until the spring of the following year, when it emerges leaving an exit hole about one-eighth of an inch in diameter.

Oak is the structural timber most commonly attacked ; the beetle may be found in coniferous woods, but only when in contact with or in the neighbourhood of infested hard woods. Sound, recently seasoned timber is not attacked. The work of the death-watch beetle can easily be distinguished from that of other wood-boring insects by the nature of the wood-dust produced by the grub. This consists of bun-shaped pellets.

Remedial and Preventive Measures

Damp, leaky or poorly ventilated wooden structures or parts of structures provide conditions favourable for the development of the beetle. It is, therefore, important in exterminating the beetle in a building to pay attention to weather exclusion and to improve the ventilation of the timbers as far as possible. In the case of a lead-covered roof, where the lead is in contact with the timber affected, the beetle in escaping from the wood may bore through the lead. When repairs are undertaken these holes should be looked for and made good. In new buildings or when replacing timbers in old buildings it is desirable to eliminate all oak sapwood since this is especially liable to attack. Many architects make a practice of specifying that there shall be no sapwood in oak supplied to their buildings.

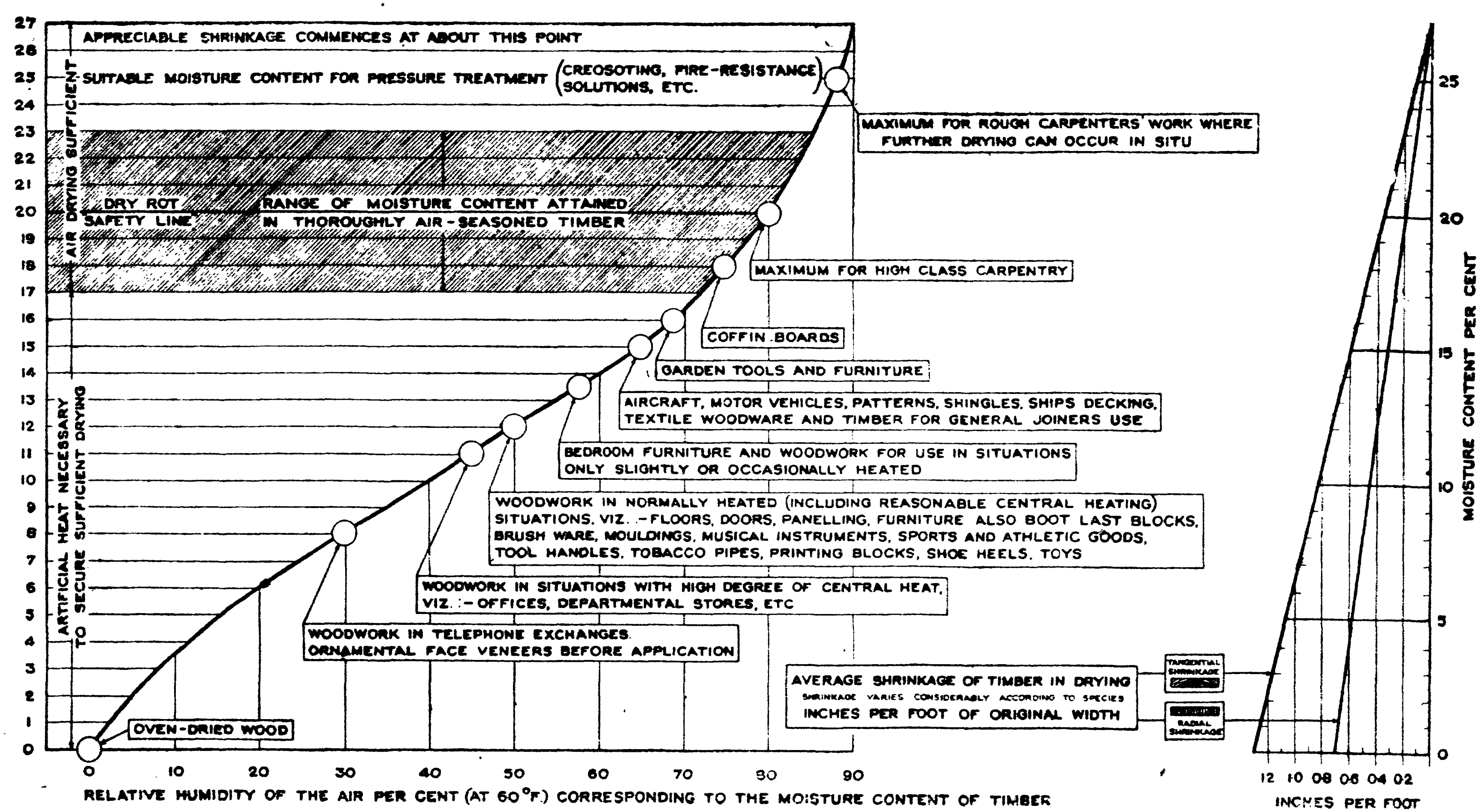
The undesirability of placing lead in contact with oak should be mentioned in this connexion for another reason than its liability to perforation by death-watch beetle, namely, that the acids in poorly seasoned oak have a corrosive action on lead. In time this may give rise to leaks and so provide suitable conditions for the insect. When repairing buildings in which oak is found in contact with lead, and particularly when new wood is being provided, it is desirable to insert an insulating paper between the two materials. (See Notes from the Information Bureau of the Building Research Station No. 118, Published in Supplement to R.I.B.A. Journal, 6th August, 1932.)

If unchecked, the beetle may so weaken structural timbers as to bring about risk of a collapse ; but owners of ancient buildings where the beetle or its workings are found are sometimes quite unnecessarily frightened into undertaking expensive replacements of timber, when the structural strength of the old wood is still entirely adequate and when it is possible without great difficulty to treat the timber and arrest the progress of attack.

Attack by *Xestobium* may suddenly terminate before all the available timber has been destroyed. When considering the treatment of a building it is, therefore, desirable to determine as far as possible whether or not the insect is still alive. Some indication of the activity of *Xestobium* in a building can often be obtained by the discovery of beetles on the floor during the emergence period, April or June. Before

MOISTURE CONTENTS OF TIMBER FOR VARIOUS PURPOSES

THE FIGURES FOR DIFFERENT SPECIES VARY, AND THE CHART SHOWS ONLY AVERAGE VALUES



treatment is undertaken a thorough inspection should be made by a competent entomologist in conjunction with an architect. The presence of fresh wood dust and the occurrence of fresh exit holes are useful indications of the presence of active insects, but it is often difficult to decide whether the dust or holes have been freshly made.

Complete extermination of beetles and grubs in a building is a slow process. There is no known substance that will be fully effective in one application. Repeated applications by brush or spray are necessary to overcome the difficulty of securing adequate penetration of an insecticide into the timber. Where discoloration of timber is of little consequence ordinary creosote or creosote derivatives are the most efficient insecticides. This should be brushed on hot. Where discoloration is undesirable mixtures are recommended which contain such substances as dichlorbenzene, chlorinated naphthalenes or colourless creosote derivatives. There are a number of proprietary preparations on the market of which two or three are more efficient than the others. The following procedure is recommended by the Forest Products Research Laboratory :—

1. Entire removal of as much infested wood as practicable.
2. Removal of superficial bore dust from timber to be treated by use of a blower or vacuum cleaner.
3. Application of insecticide by spray or brush between March and September. Annual applications over a period of four years are recommended.
4. Inspection of treated timbers, annually in spring, for a period of years after treatment.
5. Careful examination of all timbers used for repairs, to avoid re-introduction of the insect ; sound, well-seasoned timber, free from sapwood, should be utilised.

THE COMMON FURNITURE BEETLE

Description

The common furniture beetle (*Anobium punctatum* De G.) is the insect chiefly responsible for the condition commonly known as " worm " in old furniture and panelling. The beetles measure from about one-tenth of an inch to one-fifth of an inch in length, and are reddish or blackish-brown in colour. The insect is clothed with a fine covering of short yellow hairs, and the wing covers are marked by well-defined rows of small pits or punctures. The length of the life-cycle of *Anobium* appears to vary from one to two years. The beetles emerge from the wood during the period June to August, and may then be seen crawling on walls, ceilings, windows, etc., and are specially active on sunny days. They are able to fly, and can, therefore, spread infection during this time.

Results of Infestation

The eggs are deposited in cracks on the surface of the wood, in the joints of furniture, and sometimes in old exit holes. When ready to emerge the young larvae break through the base of the eggshell, thus gaining immediate entry into the wood, which they tunnel along the grain. As the larvae feed and grow the tunnels become larger and no longer run only along the grain of the wood. The exit holes are made by the adult beetles, and are about one-sixteenth of an inch in diameter, approximately half the diameter of those made by the death-watch beetle.

There are few timbers, if any, which are immune from the attack of the furniture beetle. This insect occurs quite commonly out-of-doors in dead or dying parts of trees, and in gate or fence posts. Under such conditions the injury caused is comparatively unimportant. When, however, the beetle attacks the structural timbers of old barns, sheds and similar out-buildings, or old furniture, panelling, flooring, rafters, etc., in houses the damage may become serious. In the course of a few years a chair leg, or some similar portion of furniture, may be reduced to powder. Ply-wood is not immune from attack. The presence of piles of bore-dust of cylindrical or elongate pellets is an indication of activity. The form of the dust is quite distinct from that produced by the death-watch beetle.

Remedial and Preventive Measures

There is no known substance which in one application will eradicate entirely the common furniture beetle from timber or furniture in which it is present. Repeated treatments by brush or spray are necessary. Where structural timbers in which discoloration is of no consequence are concerned, treatment with a high-grade creosote oil is recommended after removal of as much powdered wood as possible. As in destroying the death-watch beetle, it is necessary to see that the creosote is brushed on hot to as much of the timber affected as is possible, particular attention being paid to cracks and crevices.

In the case of infested furniture, where unpolished surfaces are to be treated it is often possible to eradicate the insect by painstaking applications of paraffin or turpentine, working the substance well into the wood with a brush. There are a number of proprietary insecticides on the market suitable for treatment of furniture, and several of these claim that they can be applied to varnished or polished surfaces without causing damage. Preparations containing dichlorbenzene, chlorinated naphthalenes or colourless creosote derivatives are among the most effective. In the treatment of furniture special attention should be given to joints and crevices, the undersides of chairs, backs of drawers, etc., where varnish or polish is absent, since in such places the insect lays its eggs.

Treatment by heat will also destroy the insect, provided the temperature of the deeper parts of the wood is raised to 130° F. This can be done in a timber-drying kiln, but care must be taken that moisture conditions are carefully adjusted. This is of particular importance where made-up furniture is to be treated.

Fumigation may also be used, but this process is dependent on the airtightness of the chamber in which the piece of furniture is treated. A large tightly-fitting box, a glass case, a tank or a small spare room may be used. The most effective gas to use for this purpose is hydrocyanic gas. This gas is extremely poisonous to man and should be used only by experts.

The use of the vapour of benzene, if precautions against danger from fire or lights are observed, has been suggested, but the degree of penetration is uncertain. The benzene is poured into shallow dishes or saucers and placed at the bottom of the container and left for some time. When the benzene has evaporated more should be placed in the dishes. Carbon tetrachloride, which is not highly inflammable like benzene, and for that reason safer, may be used in the same way, except that, since the vapour is heavy, the dishes should be placed on shelves at the top of the container. Carbon bisulphide may be similarly used, but, mixed with air, is liable to form an explosive mixture.

The injection of mercuric chloride into the affected wood has been used, principally in treating furniture. The material is, however, extremely poisonous, and presents no particular advantages over the safer and cheaper proprietary substances. The most effective time for the application of insecticides is during late spring and early summer, when larvae and

young beetles are near the surface of the wood. Treatment should be repeated not only at intervals during this time of year, but also for at least two years in succession.

In using new timber for structural purposes in a building treatment with creosote provides an effective method of preventing infestation by *Anobium*.

THE LYCTUS BEETLE

Description

The *Lyctus* powder-post beetles found in this country are of six species. The most abundant is *Lyctus brunneus*, an American species that has now become more abundant than the native *L. linearis*. Two other American species found are *L. Planicollis* and *L. parallelopipedus*. The adult beetles are small, somewhat flattened and elongate, varying in colour from reddish-brown to black and averaging one-sixth of an inch in length.

Results of Infestation

It was only since the war of 1914–18, that the *Lyctus* problem in this country assumed serious proportions. The importation just after the war of large stocks of American hardwoods which had accumulated, introduced *Lyctus*, particularly *L. brunneus* in large quantities. These insects appear now to have become firmly established, and though they have hitherto troubled the furniture trade more than the building industry, numerous cases have occurred of their inflicting damage to woodwork in buildings. It should be specially noted that only new buildings are attacked by *Lyctus*. In the case of one large and important building *Lyctus* was found active in an oak roof, panelling and furniture within two years of its completion. Eradication was expensive and troublesome.

Lyctus beetles lay their eggs in the pores of certain hardwoods. Oak, ash, walnut and sweet chestnut, all of which have pores large enough to contain the eggs, are timbers most liable to attack. Coniferous woods fortunately are immune. *Lyctus* confines its attentions to sapwood.

The beetles emerge in spring, in favourable conditions as early as February, and continue to issue throughout the summer and autumn. They fly readily and can thus extend the range of their attack. On hatching from the egg the young grub begins to tunnel in the wood, feeding and growing from March to October. Little sign of the attack may be noticeable until the beetles emerge twelve months after they have hatched, and it is possible for them to eat away the sapwood of a piece of timber, leaving a thin and apparently undamaged skin of wood which can often be peeled off. Holes in the wood caused by *Lyctus* are nearly always a sign that infestation is of a year or more's duration. Small piles of wood dust on the surface or areas of dust just below the surface are indications of attack. The dust has a fine floury texture and can be readily distinguished from that associated with the death-watch and furniture beetles.

Remedial and Preventive Measures

In the case of new wood it is desirable to specify that no sapwood shall be used. With oak this can easily be done and constitutes the best safeguard, since no material is then provided which *Lyctus* will attack ; with walnut the elimination of sapwood is, however, almost impossible. The use of a pore-filling polish or varnish is a good preventive, but in the case of a panelling the unprotected backs, or in furniture the unpolished undersides, should not be overlooked. A single coat of paint, varnish or linseed oil on these surfaces will suffice. This practice of closing the pores in new oak and walnut on both the exposed and hidden surfaces is probably a wise precaution to take in all new buildings.

Experiments have been made in the rendering of wood immune from attack by impregnating it with zinc chloride. This work is still proceeding and appears to be promising. Oak treated with zinc chloride takes on a slight pinkish colour, but its strength and working qualities are unimpaired.

Sterilisation by heat is effective for destroying *Lyctus*. A temperature of 130° F., maintained for 1½ hours under conditions of saturation in an ordinary timber seasoning kiln will effectively do this. The hardwood for a new building could be so treated by the timber merchant from whom it is purchased, and in the case of a costly building containing such timbers in large quantities this precaution would be well worth taking.

It is necessary to emphasise the point that the means of preventing infestation by *Lyctus* are cheap and easy to carry out when the building concerned is under construction, whereas they are difficult and expensive when the building is finished and occupied.

Where *Lyctus* is found established in a finished building measures should be taken similar to those for the Common Furniture Beetle. Again there is no treatment fully effective in one application, but Lyctus is easier to deal with by insecticides because it attacks sapwood only. The best time to apply insecticides is during spring and summer.

References

Bulletin No. 19 of the Forest Products Research Laboratory (H.M.S.O.) 1940. 1s. 6d.

"Timber Pests." (Timber Development Association). 1946. Gratis.

TIMBER PRESERVATION

Unprotected timber is the subject of attack of a number of natural agencies, chief among which are the wood destroying fungi. Timber is attacked either by direct contact with actively growing fungi or by infection by minute spores carried in the atmosphere from the fruiting bodies of well developed fungi. After infection rapid and extensive decay develops at atmospheric temperatures provided that sufficient moisture is present in the wood. Decay does not develop either in well seasoned or in waterlogged timber but, over a large range between these two conditions, the moisture content of timber becomes suitable for the active growth of fungi. Thus decay usually commences in timbers in damp situations, i.e., in contact with the ground or damp walls, or where exposed to dripping water or a constantly humid atmosphere. For example at the ground line of fence posts, in flooring boards, and joists and skirting boards and in mine timbers.

The susceptibility of different species to fungal attack varies greatly, and generally the sapwood decays much more quickly than the heartwood of the same timber.

Timber may be thoroughly protected from fungal or beetle attack by a correct antiseptic treatment, which consists of injecting a toxic substance or wood preservative into the wood in sufficient quantity to obtain and maintain an unbroken barrier of wood poisonous to the attacking agencies. Three important properties characterise an efficient wood preservative namely, toxicity, permanence and ability to penetrate wood. There are a great number of preservatives marketed, most of which fall into two types—mineral oils of which Creosote is by far the most extensively used example and water soluble salts, the best known of which are zinc chloride and sodium fluoride. The general characteristics of each type are :—

Oils.—Permanent, are not leached out by water and loss by exudation and evaporation is slow. Are thus the more suitable type for protection of timbers in exposed positions

in contact with the ground or water. Creosoted surfaces are somewhat dirty to handle and also possess an odour which renders their use undesirable for some purposes. Creosoting discolours timber and renders it unsuitable for painting. Practically odourless, refined coal tar preparations, however, are now marketed in coloured and colourless forms possessing decorative values for both interior and exterior application.

Water Soluble Salts.—Are not permanent when in contact with the ground since they are leached out by water and under exposed conditions are definitely inferior to the oil preservatives. They are, however, in the absence of wet conditions, sometimes more suitable for interior use where their non-staining and odourless properties are an advantage. Some, notably sodium fluoride, can be used on timbers that are to be painted. Others, however, are corrosive and attack iron containers, nails and woodwork fittings, for example copper sulphate and mercuric chloride.

Creosote or a refined oil preservative should be used for all exterior timbers, and for those in contact with the ground, and for interior timbers wherever possible. Water soluble salts should only be used in cases where leaching by water cannot occur.

Painting also affords protection against fungal attack if the timber is well seasoned before-hand, and provided the paint-coating is kept intact. Paint acts as both a mechanical and moisture barrier, but if, as in the case of skirting boards the timber is painted on one side only, it may encourage decay by confining to the wood any moisture picked up from damp walls. Painting, however, only retards the moisture movement in wood and does not render it damp-proof.

APPLICATION OF PRESERVATIVES

The efficiency of preservative treatment is very largely determined by the method of application of the antiseptic. Premature failures of treated timber are much more frequently due to an inadequate or incorrect method of application rather than inefficient antiseptics. Whatever method of application is used, a protective band which completely surrounds the interior wood must be obtained and kept intact.

The usual methods of application, in ascending order of efficiency, are, by brush, spraying, dipping, steeping, the hot and cold open tank processes and the pressure processes. Preservatives applied by brush, spraying or dipping penetrate only to a very small depth, and for exposed timbers the treatment must be repeated at intervals to cover any untreated wood exposed by splitting or abrasion, and to counteract the loss of any of the small amount of preservative present. The open tank process is a much better method of application providing a much deeper penetration, and a reserve of preservative against loss. It consists of completely immersing the timber in a tank of preservative and heating either by steam coils or an open fire to a temperature of 180°–200° F. This temperature is maintained for about one hour and still keeping the timber well immersed the tank is allowed to cool to atmospheric temperature. During the heating period the air contained in the cell spaces of the wood expands and some is expelled : on cooling the remaining air contracts forming a partial vacuum which draws the preservative into the wood. The cost of the equipment for this process is moderate and the method is suitable for small quantities of timber, particularly farm and estate timbers. Fence posts are frequently treated by this method at the butt end only by immersing them upright to the depth to which they are to be placed in the ground, the remainder of the post being then brushed over with hot preservative.

The Bethell, Rueping and other pressure processes are by far the most effective methods of applying preservatives, but require extensive and costly equipment, and are therefore economical only when treating on a large scale. Under these processes timber is subjected to air and hydraulic pressures both below and above atmospheric pressure. The combinations and periods of these pressures are determined by the species of timber and the purpose for which it is to be used. Pressure methods are always used for creosoting railway sleepers, transmission poles, marine timbers and some exterior structural timbers. A number of creosoting firms either market pressure creosoted timber or will arrange to pressure-treat timber for small consumers.

PREPARATION OF TIMBER FOR TREATMENT

Before treatment all timber should be well seasoned, since the presence of much moisture produces an irregular and reduced penetration, while subsequent seasoning causes splitting with liability of exposure of the untreated wood. Both outer and inner bark should be removed and the timber should be free from dirt and surface moisture. All shaping, machining or boring should be completed before treatment to avoid cutting into the impregnated wood. If any of these operations have to be carried out after treatment, hot creosote should be applied liberally to any exposed untreated surfaces. These observations apply especially in the case of applications by brush, dipping and spraying.

INFLUENCE OF SPECIES ON PENETRATION

The measure of protection afforded by antiseptic treatment is usually assessed from the weight in lb. cu. ft. of preservative injected, and this absorption figure varies very greatly for different species of timber. Many species including Beech, Sycamore, and the sapwoods of most species, for instance those of Scots and Corsican pine, are easily impregnated and give good results by open tank treatment. The heartwoods of most species are generally more resistant to treatment than the sapwoods, while some, e.g., Oak and Larch, are very resistant and can be penetrated only to a small extent even by the pressure processes.

TREATMENT OF BUILDING AND ESTATE TIMBERS

All fencing, shed timbers and other exterior structures should be thoroughly creosoted before erection. Posts and timbers in contact with the ground should receive an impregnation treatment, either by means of pressure or by the open tank hot and cold process. Application of creosote by brush to timbers in contact with the ground is recommended only when the better methods are impracticable. Hot brush application is, however, suitable for weather-boarding, fence rails, and shed timbers out of contact with the ground.

Although the possibility of fungal attack in interior building timbers is reduced by ventilation and damp-proofing methods, antiseptic treatment as a precautionary measure is warranted in many instances. Damp-proof courses and ventilation frequently fail to counteract the dampness produced in the timber framework, either by leaks from the roof, guttering and water pipes or exposed walls, and in such cases the protection afforded by antiseptic treatment is essential.

Generally creosote should be applied to joists and the underside of ground flooring, while proprietary oil preservatives or a saturated solution of sodium fluoride should be used where decorative effect or paintwork is required. The extent to which preservative treatment of interior building timbers should be carried out must be considered in each individual instance against the cost, type, and situation of the building, and it is impossible to lay down hard and fast rules.

TOWN PLANNING

NOTES ON TOWN AND COUNTRY PLANNING

The notes given below are confined to those aspects of planning which concern the architect in practice. A list of books is given in the bibliography on p. 163 suitable for those who wish to make a comprehensive study of the subject.

PRIVATE ESTATE DEVELOPMENT

Schemes for the development of private estates for building are carried out in accordance with the ordinary building law comprised in the Public Health Acts, London Building Acts, various local Acts of Parliament in force in particular towns, and the byelaws of the local authority in whose area the land is situated. But if the land comes within the area of a planning scheme, development is subject to such restrictions and conditions as may be imposed by the scheme, which may modify the previous requirements of the laws, whether in the form of statute or of byelaw.

TOWN AND COUNTRY PLANNING SCHEMES

The Town and Country Planning Act, 1932, is the principal Act ; it has been much amended by Acts of 1943 and 1944 to be mentioned below, and the law will be greatly amended by the Planning Bill now (1947) before Parliament.

SCOPE OF PLANNING SCHEMES

Under the Town and Country Planning Act, 1932, a planning scheme may be made with respect to any land whether there are or are not buildings thereon, with the general object of controlling development in the area to which the scheme applies, "of securing proper sanitary conditions, amenity and convenience, and of preserving existing buildings or other objects of architectural, historic or artistic interest and places of natural interest or beauty."

By Government Order under the Town and Country Planning Act, the whole country is now in the position of "Interim Control of Development."

PLANNING AUTHORITY FOR PURPOSE OF THE ACT

The local authorities for purposes of the Act are :—in the City of London, the Common Council ; in the County of London, the London County Council ; elsewhere, Borough, Urban District, and Rural District Councils.

The central authority is the Minister of Town and Country Planning.

Any Urban or Rural District Council may, by agreement, relinquish some or all of its powers to the County Council in whose area the district is situate.

Two or more authorities including County Councils, may appoint a Joint Committee for the purpose of preparing a scheme. The Joint Committee, so formed, must comprise representatives of each constituent authority ; also, other persons, not representing a local authority, may be co-opted on the Committee.

PROCEDURE IN PREPARATION OF A SCHEME

By the Town and Country Planning (Interim Development) Act, 1943, every local authority in England and Wales is in the same position as if it had passed resolution to prepare a scheme. The boundaries of the area to be planned are shown on a map to a scale of 25″ to 1 mile or such smaller scale as the Minister in any particular case or class of cases may approve.

At each stage all interested persons are free to inspect the maps at an address advertised in the local press by the planning authority ; objectors to the scheme may state their objections at public inquiries held by the Minister, but when the issues have been decided and the scheme finally approved by the Minister and laid before both Houses of Parliament and the period of six weeks for appeal to the High Court has expired, the scheme cannot be called in question in any legal proceedings and can only be revoked by an amending scheme. It is important, therefore, that any architect, who may be preparing an estate development plan or representing an owner of property within the area of a planning scheme, should keep in close touch with the planning authority's officers, so that the estate development will not be delayed through contravention of the final scheme.

The planning authority has power to permit interim development of estates pending the coming into operation of the scheme : see the Town and Country Planning (General Interim Development) Order, 1946, S.R. and O., 1946, No. 1621 dated 7th October, 1946, which suspended earlier similar orders.

If the Minister is satisfied on any representation, after holding a public inquiry, that a local authority have failed to adopt any scheme proposed by owners of any land in a case where the scheme ought to be adopted, the Minister may order the local authority to adopt the scheme proposed, either with or without modifications (Section 36 (3) of the Act of 1932).

THE DRAFT SCHEME

A draft of the full Planning Scheme must be published and must be illustrated by a map. The Preliminary Statement map usually includes all the features which it is desirable to settle in the scheme itself. The map accompanying the draft scheme will often not differ materially from it, but it will be on a large scale (unless the former was also on the scale of 25″ to the mile), and consequently will be prepared with the greater precision required for the illustration of the final scheme.

To assist planning authorities, a series of Model Clauses has been published from the Ministry. It is not assumed that all these clauses will be needed in every scheme, but it is intended that each of them shall be regarded as the settled form for the purpose to which it applies, subject to any necessary adaptations to meet the special circumstances of the particular scheme.

The draft scheme must be deposited for local inspection and full opportunity must be given for representations and objections. Notice must be served at this stage, as at every other stage at which a public notice is given, on every landowner concerned who has registered his name.

THE FINAL SCHEME

Within nine months from the date of their resolution adopting the draft scheme, or such other time as may be allowed, the planning authority must pass a resolution finally making the scheme, with any modifications deemed desirable after considering the representations and objections made on the deposit of the draft.

The scheme as finally made by the planning authority together with a map—which may, however, be the same as that accompanying the draft scheme—must be submitted to the Minister, who will arrange for a local public inquiry. After considering the results of the inquiry, the Minister will notify the planning authority of his intention to approve the scheme, with any modifications he considers desirable, or to disapprove it.

On receiving notification that the scheme has been approved, the planning authority must deposit the scheme as modified advertising the fact and again giving registered owners individual notice. A scheme is of cardinal importance to

the local community and to owners of property, and it is, therefore, held to be necessary to give them full opportunity to consider it in all its aspects.

The Minister, after considering any representations or objections received in consequence, will then finally approve the scheme with or without modifications, and will notify the planning authority accordingly.

The scheme will be legally binding on all persons, after the period of six weeks allowed for appeal to the High Court, or the termination of any legal proceedings instituted within that period, and the local authority will be in a position then, but not before, to enforce its provisions and to exercise any special powers given by it.

COMPENSATION AND BETTERMENT

(Sections 18 and 19 of the Act, of 1932.)

Any person whose property is injuriously affected by the making of a planning scheme may submit a claim for compensation within a stipulated period. And in cases where, by the making of a scheme, any property is increased in value the planning authority may make a claim for "betterment," viz., 75 per cent of the increase in value of the property. The amount of compensation or "betterment" is determined by arbitration under the Acquisition of Land (Assessment of Compensation) Act, 1919.

Section 19 of the Act of 1932 is of great importance to all who propose to build in the area of a planning scheme. This section enumerates the restrictions and conditions which can be imposed by the planning authority and for which no compensation is payable. These restrictions apply mainly to regulations affecting the use, density, size, height, design, or external appearance of buildings; in certain cases also they apply to the total prohibition of building operations.

"ZONING"

This is the term used for sub-divisions of an area included in a planning scheme, whereby each district or "zone" is allocated for the purpose to which it is best suited. An area may be "zoned" for the purpose of controlling the use, size, height, and density of building in each district. The principal "zones" usually included in a scheme are as follows :—

1. Industrial.
2. Commercial.
3. Residential.

No compensation is payable to owners by reason of "zoning" restrictions which the scheme excludes from compensation; and the erection of any buildings other than those specified in the provisions for each zone is a contravention of the scheme.

In each "zone" buildings other than those of the predominant use may be allowed by special permission of the planning authority. In cases where large areas of undeveloped land are included in the scheme and the future use of this land cannot be foreseen by the planning authority, it is usual to zone such land as "undetermined," but the planning authority has still the right to approve or disapprove any buildings, other than dwelling-houses, residential buildings and public buildings, which it is proposed to erect on the "undetermined" zone. The density of building to be allowed may vary in different areas. The usual maximum density is an average of 12 houses to the acre and a density below an average of 4 to the acre is not usual. This allows a reasonable elasticity in planning and grouping of buildings. In some cases, areas may be approved by the Minister at a much lower density provided no objection is raised by the interested owners.

RURAL ZONES

In many schemes it may be found desirable to schedule a "Rural Zone" in which, although predominantly rural in character, a very low density of building is allowed, e.g., 1 house to every 5 or even 10 acres. Provision could be made in the scheme for groups of buildings at selected points.

RESERVATIONS

In an area to be developed it is desirable to allow 10 per cent of the whole area as open spaces, plus 5 acres (minimum) per thousand of population as playing fields. Land required for open spaces, recreation grounds, etc., is indicated in the scheme as (*a*) Public Open Spaces (*b*) Private Open Spaces. That required for public use is acquired by agreement with the owner or purchased compulsorily with the approval of the Minister. "Private Open Spaces" may be scheduled by agreement with the owner, in which case no compensation is payable.

AGRICULTURAL RESERVATIONS

In some cases land can be reserved for agriculture (by agreement with the owner) where it has no prospective building value, or is otherwise unsuitable for building, such as land liable to floods, moorlands, steep slopes of valleys, and farm lands remote from roads and public services; in such cases it is unlikely that compensation would be payable for reservation from building.

Wherever possible, open belts of agricultural land should be reserved, if suitable for this purpose, in order to confine the building zones within reasonable limits and to prevent sporadic building over wide areas. In the agricultural belt only buildings necessary for farming purposes (including cottages for those working on the land) would be permitted.

WAR DAMAGE AND REDEVELOPMENT

The Town and Country Planning Act, 1944, contains a code of law for what are popularly called "blitzed and blighted" areas.

It also contains provisions, going far beyond town planning, on the subject of the price to be paid for land by public authorities, central and local. For this Act, see the text books and memoranda mentioned in the bibliography.

PUBLIC BUILDINGS

Areas in which these buildings may be erected should be allocated in any planning or estate development scheme, usually in a central and dominating position. Public buildings of closely related function should be grouped together, for example—(1) Civic centres comprising administrative and local government buildings. (2) Social and recreational buildings. (3) Educational buildings.

Note.—

(*a*) Sites for schools require a minimum of road frontage but ample space for playgrounds in rear of buildings.

(*b*) Churches should generally be separated from the civic centre and shopping streets, and they may well be placed on important sites in the residential area.

SHOPS AND MARKETS

For commercial reasons and for the convenience of customers these are best planned in groups to form a "market" rather than in isolated positions. A site for a public market, covered or open, should be adjacent to the shopping centre. Bank sites are usually in the shopping area. It is rarely a commercial proposition to provide more than one average sized shop for every two hundred persons of population served.

RAILWAY STATIONS

Ample space should be allowed for goods yards, for parking space in station forecourt, and for a motor-bus station adjacent. The approach from station to the town centre should be obvious and direct.

ROADS

Allow 10′ minimum for each line of vehicles. Overall width of road is dependent on volume of traffic ; for a main road normally 100′ between fences is adequate : for parkways a greater width is desirable. A 100′ main road in open country would allow 40′ carriage-way, 2 footpaths each 4′ 6″ wide and the remainder as grass verges. Where a main road passes through a built-up area or shopping centre, service roads should be provided at each side of the through traffic route to allow for local standing vehicles. For residential roads with little traffic 50′ between fences is adequate, with 20′ carriage-way. Grass verges of less than 8′ in width are unsatisfactory and difficult to maintain in condition. Tree planting is generally most effective on parkways and certain residential roads ; trees are rarely appropriate for shopping streets. The general treatment of roads depends on the character of the areas which they serve.

The County Council is now the responsible authority for all public highways in rural districts.

Under the Restriction of Ribbon Development Act no building may be built within 220′ of the centre of any classified road without express consent from the highway authority—usually the County Council. The highway authority may purchase compulsorily land within 220 yds. of the highway, and also has complete power to refuse or permit any means of access to a classified road.

REQUIREMENTS OF INDUSTRY

Sites for factories should be grouped in one area with good road approaches from neighbouring towns. Certain industries will require to be adjacent to a railway with sidings. The grouping of factories, as at Letchworth, Welwyn and Bromborough Port ensures economy in the supply of public services. Sites for light industries are usually 200–300 feet deep.

At least 50 operatives are required for every acre occupied by factories, and on this figure can be based the housing accommodation required for the operatives and their families. In cases where the factories are productive of smoke and noxious fumes, the factory area should be placed on the side of the town furthest from the prevailing winds, provided that the contours and road approaches are suitable. Low-lying land with good sub-soil, if not liable to floods, may well be utilised for industry.

VACUUM CLEANING

Vacuum or suction cleaning equipment is available in sizes and types suitable to all conditions, from the smallest household type to large central plants serving hose connexions distributed about a building.

Essentially a suction cleaner consists of a fan, which causes a relatively high velocity air stream to pass into the orifice of the cleaning tool. The dust is carried into a suitable receptacle, which may be emptied as required. In small units the fan is of the multi-bladed propeller type, fitted into a casing ; larger units consist of fans of the turbine type, with one or more stages depending on the duty required. Whether a central equipment is installed in a building, or whether portable plants in selected positions, will depend on the type of building and the conditions under which cleaning is likely or able to be carried out. In department stores, cinemas, theatres and other buildings in which the cleaning is limited to fixed hours, the conditions are more favourable to a central plant with hose connexions at suitable positions throughout the building ; but in buildings where the cleaning may be spread over lengthy periods and where only comparatively few operators are working at one time, the installation of a central plant may mean that a large machine is running more or less constantly with only one or two hose connexions in use. In such cases portable units will probably mean lower first costs and considerably lower running costs.

When a central plant is installed great care should be taken to ensure that the pipework is carried out in a first-class manner, and that all bends and sweeps are easy. It is usually safer to insist that a specialist firm be employed.

It should be noted that hose connexions taken directly off risers will require deeper chases than would be required by most other pipe services, and it is frequently necessary to provide special chases in corridors or to accommodate the risers in the rooms, with the hose connexions in the corridor or an adjacent room or space.

It is important to allow for sufficient hose connexions to obviate the use of hose of long lengths. A reasonable limit is 50′ and it is found in practice that cleaners object to using vacuum cleaning equipment if longer hoses are necessary, and will scamp the work. All hose used should be of a type that will not damage door frames, wood-work or furniture when dragged from one place to another. Projecting hose connexions should be avoided in main traffic ways.

A clause should be inserted in the specification stipulating that the plant should be a quiet running one. Turbines run at high speeds and, together with their motors, are frequently noisy in operation. In addition, the exhausting of large volumes of air can be a great nuisance unless precautions are taken to silence such exhaust.

VENTILATION

Mechanical ventilation is applied mainly to such buildings as are required by law or the regulations of city or county authorities to maintain a standard of quantity and purity of air—such as theatres, cinemas, places of public resort, factories and workshops—and to offices, stores, etc., where the required air change would be difficult to obtain by natural means.

Three systems are in general use, the choice depending on the conditions of service and the standard of quantity and purity desired.

(1) Mechanical inlet or plenum system, with natural extract, in which the fresh air is drawn in and distributed by means of a fan, and the vitiated air leaves the building by intended or accidental outlets. The incoming air may be, and frequently is, cleaned and warmed prior to its delivery.

(2) Mechanical extract system, with intended or accidental inlets, in which the above conditions are more or less reversed. In many instances the air is drawn from outside over radiators, through gratings and regulators ; in which case warming and ventilation are combined. If such a method is adopted, care must be taken to ensure that the radiators are of sufficient capacity to deal with the incoming air as well as with the normal heat losses through the structure. With this arrangement the air is seldom cleaned or otherwise treated.

(3) Combined or balanced system, in which the air is mechanically introduced and extracted by means of fans, and a balance or slight pressure is maintained in the spaces

served. With this system no outside air should be introduced—except such as has been delivered by the fan—and windows should be kept closed. The provision of separate ducts for inlet and extract is required, and it is usual to filter and/or wash the incoming air, control its humidity within limits and raise the temperature during the winter. The incoming air is introduced through one service of ducts and extracted by a separate fan or fans through another. The inlet fan and conditioning plant are usually, though not necessarily, located in the basement or lowest floor : the extract fan or fans on the roof.

The quantity of fresh air necessary to maintain suitable conditions depends on the character of the building. Most public authorities require the introduction of a minimum of 1,000 cu. ft. of fresh air per person per hour ; the air to be cleaned and, in winter, warmed to maintain—either alone or supplemented by other heating units—a temperature of 55° F. when the building is unoccupied. A common practice is to instal plant capable of dealing with twice this quantity of air in summer, to increase the air changes.

Recirculation of the air is not allowed in the case of installations under the control of public authorities, but is frequently done in private plants—with a consequent saving in fuel costs—and is a general practice in other countries. The amount recirculated varies, but from 40 per cent to 75 per cent provides satisfactory operation. Provided recirculated air is properly conditioned before re-entry to the rooms or space served, there is no doubt of its suitability for respiratory purposes in ordinary domestic practice ; and where plants are not under the control of a public authority, and fuel consumption is an important factor, such a system should be given full consideration. With industrial plants, however, vitiation may be so great as to render the air totally unsuitable for further use after ordinary conditioning treatment.

The plenum system is a combined central heating and ventilating service and has the advantage of controlling the relative humidity of the air within certain limits. In hot weather actual cooling of the air may be effected by the addition of refrigerating equipment. The extent of the duct work required for such a system is a factor militating against its more general adoption. Ducts may be formed of the structural materials and, in many cases, as part of the structure ; or they may be of sheet metal or metal-faced plywood. Circular ducts offer less resistance to the airflow than rectangular ducts of equivalent area, but are not always suitable. Where the use of rectangular sections is necessary, the ratio of width to depth should be kept as low as practicable : it should never exceed 8 or 10 to 1. No duct should be less than 6″ in depth, and those having a depth of 12″ or more should be stayed internally. The speed of the air in metal ducts should not exceed 20′ per second—particularly if noise is likely to cause difficulty ; and through inlet or extract gratings it should be kept low (4′ to 6′ per second) to avoid local discomfort, and any gratings near ceilings should be fitted with deflectors to prevent local discolouration.

A suitable insulating joint should be inserted close to the fan in the ductwork, to minimise the risk of noise being transmitted from the fan to the rooms or spaces served.

See P.W.B.S. No. 10 " Mechanical Installations." (H.M.S.O.) 1944. 2s. 0d.

L.C.C. REQUIREMENTS

The following are the principle requirements of the L.C.C. with regard to ventilation.

AIR BRICKS AND SHAFTS

Every room used as an office or habitation requires additional ventilation by means of an aperture or air shaft communicating either direct to the open air or to a lobby or corridor ventilated direct to the open air unless :—

(*a*) It is ventilated by a ventilating system.
(*b*) It is provided with a fireplace having a flue at least $7\frac{1}{2}''$ across in any direction.

AREA OF AIR BRICKS AND SHAFTS

Every aperture or air shaft requires an unobstructed sectional area of :—

(*a*) 50 sq. in. if communicating direct to the open air.
(*b*) 100 sq. in. if communicating with a lobby or corridor.

Where an ordinary open domestic gas fire is fitted having a flue not exceeding 30′ in height the sectional area of the flue may be reckoned as part of the area required.

ARTIFICIALLY VENTILATED ROOMS

Where it is not possible to obtain natural ventilation for a room used as an office or for habitation, a means of ventilation capable of supplying 750 cu. ft. of fresh air per person per hour or per 50 sq. ft. of floor area (whichever is the greater) shall be provided. All bathrooms shall be ventilated to the satisfaction of the District Surveyor.

VERMIN IN BUILDINGS AND THEIR EXTERMINATION

LEGAL PROVISIONS

Outside London, local authorities are, by Section 83 of the Public Health Act, 1936, empowered to require the cleansing of filthy or verminous premises. The powers are drastic and include the power to compel occupiers to leave premises temporarily in order that gas may be used. In London, metropolitan borough councils have parallel (though less explicit) powers under Section 123 of the Public Health (London) Act, 1936, In the case of gas the Hydrogen Cyanide (Fumigation) Act, 1937, lays down precautions to be taken.

THE BED BUG

Description

The adult bed bug (*Cimex lectularius* Linn.) is a flat, oval, wingless creature with three pairs of legs. Its colour is chestnut or mahogany brown when it is unfed, but after feeding it is much darker in colour, elongated and swollen. The insect is nocturnal in its habits, feeding at night and returning at once to its hiding place where it spends the rest of its time. This hiding place is usually out of sight but sometimes in heavy infestations bugs will remain in the open and quite visible in the daytime. A characteristic of the bug is its smell, which is curiously musty and quite unmistakable when once it has been experienced. The adult bed bug can live for six months without food and, when conditions are unfavourable, for four years or more in houses or even outside ; under favourable conditions the life cycle is completed much more rapidly. It is exceedingly resistant to frost and to heat though 113° F. and above is said to be lethal to it.

Common hiding places of the bed bug are : in mattresses and the crevices of beds ; in the cracks in furniture, in upholstered furniture, more especially where the upholstery is attached to the frame ; behind pictures and picture backings ; on the underside of seats of chairs, etc. ; in the fabric of the house—behind wallpaper, especially where pouched or overlapped against woodwork ; behind picture rails, skirtings, architraves and mouldings, and pipes fitted

against the wall ; in floorboards ; in cracks in plaster-work, nail holes, and in similar situations.

How Infestation Spreads

The bed bug can be distributed in many ways but probably the most usual source of infestation is the movement of furniture from bug-infested premises to another house without steps being taken to see that it is disinfected on the way. Another is the purchase of second-hand furniture after the original furniture has been cleansed. Given ample food supply and comfortable living accommodation, the bug does not migrate. The use of infested material from demolished houses, either as firewood or in other ways, is a potential source of danger.

The importance of providing as few hiding places as possible may well be noted here particularly in new housing estates, which are very liable to become infested. Woodwork, particularly skirtings, architraves and picture rails, should be reduced to a minimum, and wallpaper is undesirable.

Remedial and Preventive Measures

There is only one certain method known at present of killing bed bugs and their eggs, and that is by the use of hydrocyanic acid gas.

However the insecticide DDT has given most promising results and seems likely to supersede older methods. Both 5 per cent DDT powder and sprays of 5 per cent DDT solution have been used with complete success in Glasgow and elsewhere against severe infestations of long standing.

With hydrocanic acid gas it is necessary to evacuate the treated house for 24 hours. If the house is one of a row, the house on each side must also be evacuated for about 7½ hours. The Ministry of Health Report on Public Health and Medical Subjects, No. 72, on the bed bug, published by his Majesty's Stationery Office, 1934, price 1s. 0d., contains a detailed account of the bed bug, its life history, means of dissemination, methods of control and recommendations with regard to structures most fitted to resist bed bugs.

THE FLEA

Description and Causes of Infestation

In this country various species of flea are common : the human flea, *Pulex irritans* Linn. ; the dog flea, *Ctenocephalus canis* Curtis ; and the cat flea, *Ctenocephalus felis* Bouchè ; and occasionally the plague flea, *Xenopsylla cheopis* Rothschild.

The flea is a light brown insect which is flattened from side to side, without any noticeable constrictions ; the hind legs are modified for jumping. Unlike the bed bug the flea feeds very frequently, and is usually carried on the body of its host. The young of the flea is a legless, hairy maggot, and lives upon organic debris, such as wool fluff and hair that it finds in the cracks of floor-boards, etc. When about to go into the resting or pupa stage it forms a cocoon which is often covered with particles of dust, grit, etc. The adult hatches out inside this cocoon and in empty houses may remain there for a long time before it emerges.

Results of Infestation

Xenopsyall cheopis, and perhaps other species, which infest the black rat is capable of picking up the bacilli of plague from infested animals and passing it on to man. Plague is still prevalent in many of the ports fo the world, though the black rat is not so common as previously in this country. The making of rat-proof buildings has tended to keep the sewer rat (an enemy of the black rat) out of houses, but does not always exclude the black rat, which sometimes gains access along telephone wires, etc.

Remedial and Preventive Measures.

It is important to keep domestic animals free from fleas and to kill all fleas found singly in houses. If a room is seriously infested, flaked naphthalene or para-dichlor-benzene crystals should be sprinkled in quantities on the floor and the room shut up. Fumigation with sulphur and spraying with one of the light paraffin-basis sprays are also effective.

ANTS

Description and Causes of Infestation

The ant most usually troublesome in houses is *Monomorium pharaonis* Linn. This is a very small red ant which is often found in the basements and foundations of bakehouses, hospitals, etc. They infest larders and kitchens, feeding on a wide variety of human food.

Remedial and Preventive Measures

The best method of extermination is by the use of a poison bait ; a formula that has often been used with advantage is :—

Poison

6 parts by bulk sodium fluoride.
2 ,, ,, fresh pyrethrum powder.
2 ,, ,, corn starch.

This should be sprinkled in the runways of the ants, care being taken that foodstuffs are not contaminated, and that children and domestic animals have no access to the mixture.

If the ants are gaining access from outside, grease-banding the house will help to check the nuisance.

COCKROACHES

Description and Causes of Infestation

There are two species common in this country. The common cockroach (*Blatta orientalis* Linn.) is a dark brown flattish insect, the male having wings which do not quite reach the end of the body ; in the female these are reduced to mere rudiments. The German cockroach (*Blatella germanica* Linn.) is much smaller than the common cockroach, and the wings extend the full length of the body ; it is sometimes known as "the steam bug," and is often found in laundries. Cockroaches live in cracks and crevices in kitchens, bakehouses, restaurants, etc. They like the dark and will scatter for shelter if a light is turned on. They eat a wide variety of substances, including paper and leather, besides ordinary human food. They are probably introduced in packing material which has been stored in an infested warehouse or ship.

Remedial and Preventive Measures

It is advisable to "make good" cracks and crevices, particularly in skirtings ; this can be done with a pulp of newspaper and size, with putty or cement mortar, whichever is suitable. Poison baits are the usual means of extermination. However, DDT embodied in oil-bound distempers has given remarkable results, and will probably supersede the somewhat unreliable method of poison-baiting which is never 100 per cent effective.

CRICKETS

Description

The cricket (*Gryllus domesticus* Linn.) is a medium-sized winged insect with highly developed hind legs. The characteristic chirp is produced by rubbing one wing case or tegmen over the other. They normally live near hearths, hot pipes and similar warm places.

Results of Infestation

The cricket lives on crumbs and similar refuse and acts as a scavenger. In this respect it is beneficial and it does no damage whatsoever. They are often prevalent near refuse

dumps as the decaying organic matter affords them a suitable breeding ground.

Remedial and Preventive Measures

If it is desired to destroy these insects the best method is to employ a poison bait. The formula containing sodium fluoride recommended for ants may be used.

DDT has been shown to be highly toxic to these insects.

PSOCIDS (BOOK-LICE) AND THEIR ALLIES

Description and Remedial Measures

Several species of these insects occur in houses in this country and one might mention the following, *Clothilla picea* Motsch., *Trogium pulsatorium* Linn., and *Liposcelis divinatorius* Mill.

These minute, soft-bodied insects, either light or dark in colour, are found in nearly all new houses and can move with great speed. They live on fungi and moulds and are present until brickwork and plaster have dried out. Thorough drying of the building will cause them to disappear.

SILVER FISH

Description

Lepisma saccharina Linn., is a silver grey insect very prevalent throughout the country, of nocturnal habits, and a very rapid mover. It lives in warm places such as around hot pipes, hot tanks, boilers and so on.

It seldom does any damage, living on starchy materials such as crumbs, paste from behind wall paper where this has become detached, gummed substances, etc. In rare instances it may cause damage in endeavouring to get at starchy substances and has been known to attack artificial silks where these have been treated with starchy material. It usually acts as a scavenger.

Remedial Measures

The silver fish is best exterminated by the bait suggested for ants—sodium fluoride, pyrethrum powder and starch. DDT is also very effective.

Reference :

T. F. West and G. A. Campbell " DDT the Synthetic Insecticide." (Chapman and Hall). 1946. 21s. 0d.

WALLS

(Including " Party Walls.")

In London, the thickness of walls in relation to their height ; the use of piers and cross walls, cavities, etc., are now governed by byelaws made by the L.C.C. replacing the older provisions of the London Building Acts. Outside London, these matters are (except in some half dozen towns where there are special Acts of Parliament) governed by byelaws of the local authority which will be found to agree with the model byelaws issued from the Ministry of Health. Since the byelaws are intended to be modified from time to time and kept up to date their actual requirements should be consulted. Whilst variations will not be found to occur as between one provincial area and another, it has to be borne in mind that the L.C.C. byelaws do not follow the model byelaws, though the general effect is similar in all important matters.

PARTY WALLS

PROCEDURE IN THE METROPOLITAN AREA

The procedure to be adopted with regard to party walls in London is now contained in Part VI of the London Building Acts Amendment Act, 1939, which is in effect a code creating and regulating the mutual rights of building owners and adjoining owners. This part of the Act deals with notices and counter notices ; certain precautions to be observed when work is done upon a party wall ; the division of expense ; and the determination of differences between owners by a single agreed surveyor or by three surveyors. If three are appointed, the third surveyor is only called in to act as Arbitrator in the event of the two appointed surveyors :

1. Being unable to agree the terms of the award,
2. Being unable to settle any dispute that subsequently arises between them.

If he is called upon, then the three surveyors or any two of them can conclude an Award or settle the matter in dispute. Either building or adjoining owner can appeal to the County Court to rescind or nullify an Award and there is power under certain circumstances to have the matter decided in the High Court. (Section 55.)

It should be noted that this part of the Act of 1939 contains a definition of the phrase " party wall " which is not the same as the definition for purposes of the remainder of the Act.

The agreed fees of the adjoining owner's surveyors are stated in the Award and become payable immediately it is signed. A payment in respect of the additional user of the party wall is usually a matter of subsequent negotiation between the parties. The amount, may, however, be assessed and stated in the Award ; or the Award may state that the building owner will pay in accordance with the provisions of Section 56.

Note.—The Surveyor's fees of the adjoining owner are payable by the person making the application.

If, however, the adjoining owner seeks legal advice then he is himself responsible for payment of the legal costs due.

(The Land Charges Act, 1925, requires that where an owner of property by agreement or award restricts the user of or creates a right over any land (not being a legal easement) such agreement or award must, to ensure its validity against all parties, be registered under Section 10 of the Land Charges Act, or alternatively in the case of registered land by entering a caution under Section 59 of the Land Registration Act, 1925. It has been suggested by the Practice Standing Committee of the R.I.B.A. that the following should be included—(*a*) " These presents shall be registered, at the sole cost of the Building Owner, as a Land Charge under the Land Charges Act, 1925 " or (*b*) " These presents shall be registered at the sole cost of the Building Owner, against the registered titles of any of the parties herein to the land aforesaid under the Land Registration Act, 1925.")

PROCEDURE OUTSIDE THE METROPOLITAN AREA

(Law of Property Act, 1925, and Local Byelaws.)

The procedure relating to party walls set out in the London Building Act Amendments Act, 1939, does not apply to party walls outside the County of London. Section 38 of the Law of Property Act, 1925, relating to party structures is as under :

38. (1) Where under a disposition or other arrangement which, if a holding in undivided shares had been permissible, would have created a tenancy in common, a wall or other structure is or is expressed to be made a party wall or structure, that structure shall be and remain severed vertically as between the respective owners, and the owner of each part shall have such rights to support and user over the rest of the structure as may be requisite for conferring rights corresponding to those which would have subsisted if a valid tenancy in common had been created.

(2) Any person interested may, in case of dispute, apply to the court for an order declaring the rights and interests under this section of the persons interested

in any such party structure, and the court may make such order as it thinks fit.

Part V. of the First Schedule to the Act sets out the provisions as to party structures. Paragraphs 1 and 3 read as under :—

1. Where, immediately before the commencement of this Act, a party wall or other party structure is held in undivided shares, the ownership thereof shall be deemed to be severed vertically as between the respective owners, and the owner of each part shall have such rights to support and of user over the rest of the structure as may be requisite for conferring rights corresponding to those subsisting at the commencement of this Act.
2. Any person interested may apply to the court for an order declaring the rights and interests, under this Part of this Schedule, of the persons interested in any such party structure or open space, or generally may apply in relation to the provisions of this Part of this Schedule, and the court may make such order as it thinks fit.

It will be observed that the phrases " party wall " and " party structure " are not defined. They will not necessarily bear the same meaning as in Acts of Parliament or byelaws dealing with the construction of walls.

Some local Acts provide as to the raising of chimneys in party walls as under :—

In the case of any building erected or raised to a greater height than the adjoining building, and in the case of any flues or chimneys of such adjoining building as are in the outer or party wall or against the building so erected or raised, the person erecting or raising such building shall at his own expense build up those flues and chimneys so that the top thereof may be of the same height as the top of the chimneys of the building so erected or raised or the top of such last-mentioned building whichever may be the higher.

In practice the raising or alteration of party walls by one owner is carried out in accordance with the law and the foregoing provisions that one half of the party wall belongs to one owner and the other half to the other owner. As a general rule there is very little difficulty in agreeing by negotiation with the adjoining owner as to party wall alterations. A short agreement setting out the work to be done and the liability in the event of damage is usually entered into between the parties.

WATER CLOSETS, EARTH CLOSETS AND PRIVIES

Sections 43 to 45 of the Public Health Act, 1936, deal with buildings (new or existing) which are without a sufficient water closet, earth closet or privy and ashpit. In London there are parallel provisions in Section 101 of the Public Health (London) Act, 1936.

The actual construction of water closets, earth closets, chemical closets, and privies (as to which see " Sanitary Accommodation " and " Chemical Closets " under " Sewage Disposal ") is governed by byelaws of the local authority which (outside London) will be found invariably to agree with the model byelaws issued from the Ministry of Health, and (in London) by byelaws made by the L.C.C.

WATER SOFTENING

Water supplied by public authorities is, in the majority of cases, of a " hard " nature, due to the presence of salts of calcium, magnesium and iron. When due to carbonates of calcium and magnesium, the hardness is known as " temporary " and may be reduced by more or less prolonged heating at temperatures below boiling point. Such heating drives off the CO_2 and allows the salts to deposit as insoluble carbonates, resulting in incrustations on the walls of hot water boilers, storage cylinders, calorifiers, pipes.

Permanent hardness is due to sulphates and chlorides of the above salts, and is only precipitated by boiling at higher temperatures and pressures, as in the case of steam boilers. Soap does not lather readily in hard water. Where permanent hardness is excessive the water may be undrinkable. For these reasons, hard water should be softened before use, and the two methods in general use for this purpose are known as the Base-Exchange or Zeolite and the Lime-Soda. The former method is probably the more popular for general domestic use. The process consists of passing the water to be treated through a bed of porous silicate, which has the property of chemically absorbing lime and magnesia from the water. Each bed, depending on its volume, is designed to deal with a certain quantity of water ; when this quantity is treated and used, the bed is revivified by the application of a common salt solution, which passes to the drain ; after which the bed is ready for a further cycle.

The differences in the various types of Zeolite softeners on the market are principally in the nature of the material used—some being natural mineral and others synthetic—and in the volume of the bed. Some materials appear to be unstable and to have a short life in consequence. The volume of the bed must be such as will deal thoroughly with the quantity of water passed between regenerations. As the dimensions and prices of the various types of apparatus vary widely, it is advisable to obtain expert opinion on the plants offered.

The Lime-Soda type of softener operates, as the name implies, on the principle of adding doses of lime and soda to the water. This type of plant, generally, is more accurate in its treatment than the Base-Exchange. There are, however, certain disadvantages connected with its use ; the sludge resulting from the treatment has to be disposed of ; also, being essentially a system depending on correct measuring and dosing, it operates by gravity and in most cases must be placed at a high level, and in consequence tends to be neglected. Where the water is very hard, or where it is required for steam boiler feed purposes, the Lime-Soda type of plant should be installed. With this type also, expert opinion should be obtained to ensure that the most suitable measuring and dosing apparatus is procured and that the plant is placed in the most suitable and economical position from the point of view of pumping costs. All waters do not require softening treatment, the composition in many cases rendering them naturally soft, but highly corrosive. In such cases, and with waters which are acid or become acid on heating—such as those containing magnesium chloride—it is wisest to submit samples for chemical analysis and obtain expert opinion as to the most satisfactory method of treatment.

WATER SUPPLY

LEGAL BACKGROUND

The law affecting water supply and water fittings is to be found mainly in the Public Health Act, 1936 (outside London) ; the Public Health (London) Act, 1936 ; the Water Act, 1945 ; and local and special Acts of Parliament promoted by water boards, water companies, or local authorities in their

capacity of water undertakers. The Public Health Act, 1936, and the Water Act, 1945, and most of the special Acts not only contain direct provisions, but also authorise the making of byelaws which, under all modern Acts, require confirmation by the Minister of Health. Very great confusion exists in the law of water supply, because so much of that law is contained in special Acts, which do not agree among themselves or with the general Acts. In the Public Health Act, 1936, and to a greater extent in the Water Act, 1945, Parliament has contemplated supersession of these special Acts by general and uniform provisions, either at the instance of the water undertaker concerned or, in the last resort, upon compulsion applied by the Minister of Health. It will, however, at the best be many years before substantial uniformity can be achieved. Meantime the architect who is concerned with the water supply, plumbing, and drainage arrangements of a new building, or is modernising an existing building, will (in most areas) have to ascertain the position from the water undertakers in the first place. When in doubt, or when he has reason to think that the demands of the water undertakers are excessive, he should advise his client to seek competent legal advice, as to whether the requirements of the water undertaker can be enforced.

WATER SUPPLY TO HOUSES

Under Sections 137 and 138 of the Public Health Act, 1936, as amended (substantially) by Sections 29 and 30 of the Water Act, 1945, a local authority may require the provision of an adequate water supply to any house, new or already in existence, subject (in existing houses) to certain limits of cost laid down. There are rights of recourse to a Court of Summary Jurisdiction if their requirements are disputed. Broadly similar provisions occur in Sections 95 and 97 of the Public Health (London) Act, 1936. In regard to London, it has to be remembered that much of the area supplied by the Metropolitan Water Board lies outside the County of London, and so is governed by the provincial law of public health as well as by the Metropolitan Water Board's special Acts, but not by the Public Health (London) Act, 1936.

WATER MAINS THROUGH PRIVATE LAND

Under Section 119 of the Public Health Act, 1936, the local authority have the same power to lay water mains over private land as in the case of sewers. (See page 53.)

POLLUTED WATER

Under Section 140 of the Public Health Act, 1936, the local authority have the power to require the closing or regulating of any polluted well, tank, or cistern the water from which is likely to be used for human consumption.

WEIGHT OF WATER

Measure	Volume	Weight
1 gallon	277·46 cu. in.	10 lb.
1 gallon	·16 cu. ft.	10 lb.
6·24 gallons	1 cu. ft.	62·4 lb.
11·2 gallons	1·8 cu. ft.	1 cwt.
224 gallons	35·9 cu. ft.	1 ton
(Sea Water)		
6·24 gallons	1 cu. ft.	64 lb.

Ice weighs 57 lb. per cu. ft.
The maximum density of water is at 39·2°F.

HEAD OF WATER

The pressure at any point in a supply system is dependent upon the vertical distance of that point below the free surface of water in the tank or reservoir. This vertical distance is called the head of water at that point, and is measured in feet. The pressure in lb. per sq. in. for any given head of water is found by multiplying the height in ft. by ·433, or is very approximately ½ lb. per sq. in. per ft. head of water.

WATER CONSUMPTION

The increase in the water consumption per head of population is largely due to improved sanitation and the installation of a bath and hot water system in most dwellings. Families which previously used from 6 to 7 gallons per head daily, now require 20 to 30 gallons ; middle-class houses 35 to 40 gallons and large mansions from 60 to 70 gallons. Some hotels require as much as 200 gallons per head per day.

The following Table gives the minimum consumption for various types of building :—

Type of Building	No. of gallons per head per diem
Small dwelling houses and flats ...	30–40
Large dwelling houses and flats	40–70
Hotels	35–60
Office buildings	10–20
Ordinary schools	10–15

With each self-contained building or flat one draw-off tap should be fixed to enable a supply of water direct from the main to be obtained for drinking purposes. All other draw-off taps, etc., must be served from a proper storage cistern. It is recommended that such a storage cistern should be of sufficient capacity to hold a 24-hours' supply. In the smallest house the tank should not be less than 40 gallons' capacity. Where the main pressure is under 25 lb. per sq. in. larger tanks should be installed.

Galvanised iron tanks are most generally used and should be specified "to comply with the British Standard 417 : 1944 for galvanized mild steel cisterns, the grade to be clearly marked on the finished article."

Tanks should always be covered and cased in and packed with slag wool or sawdust or other suitable insulating material affording protection from the action of frost.

CAR WASHING

Some Water Boards allow car washing to be done only through a meter, while others insist on the garage supply coming through the cistern.

Some authorities give a rebate on the water rate if a car is washed without the use of a hose.

STOP COCKS

In the case of the cold water supply system these are usually fitted to the service pipe from the Company's main at or near the point of entry to the house, and to the main supply pipe at or near the storage cistern. The service pipe from the Company's main has an additional stopcock outside the building. It is also advisable to fit stopcocks to all branch runs from the main supply pipe, thus enabling local disconnection to be effected for the purpose of repairs, etc., without the necessity for disconnecting the whole system.

CISTERNS FOR DOMESTIC WATER SUPPLY

Under Section 141 of the Public Health Act, 1936, any well, tank, cistern or water-butt used for the supply of water for domestic purposes, which is so placed, constructed or kept as to render the water therein liable to contamination is deemed to be a nuisance under the Act.

STORAGE CISTERNS

British Standard sizes are listed on p. 116.

RECOMMENDATIONS OF THE METROPOLITAN WATER BOARD AS TO STORAGE CISTERNS

The table given below shows the minimum size of storage cistern and supply pipe from this cistern recommended by the Metropolitan Water Board :—

	Storage capacity Galls.	Size of Down Pipe In.
(*a*) For a house or building or part of a house or building of 6 rooms or less without a hot water system ...	60	$\frac{3}{4}$
(*b*) Ditto, with a hot water system ...	80	$\frac{3}{4}$
(*c*) Ditto, of 9 rooms	120	$\frac{3}{4}$
(*d*) Ditto, of 10 rooms	135	$\frac{3}{4}$
(*e*) Ditto, of 12 rooms	160	$\frac{3}{4}$
(*f*) Ditto, of 15 rooms	200	1
(*g*) Ditto, of 20 rooms	270	1
(*h*) For a building containing 2 tenements	90	$\frac{3}{4}$
(*i*) Ditto, 3 tenements	120	$\frac{3}{4}$
(*j*) Ditto, 5 tenements	200	1
(*k*) Ditto, 6 tenements	210	1
(*l*) Ditto, 10 tenements	350	$1\frac{1}{4}$
(*m*) Ditto, 12 tenements	360	$1\frac{1}{4}$
(*n*) Ditto, 20 tenements	600	$1\frac{1}{2}$
(*o*) Ditto, 50 tenements	1,250	Dependent on arrangement of cisterns, which would probably be divided.
(*p*) Ditto, 120 tenements	2,350	
(*q*) Ditto, 150 tenements	3,500	

COMMUNICATION PIPE

The length of pipe from the public main to the stop-cock (if any) outside the building is known as the communication pipe and is usually of $\frac{1}{2}''$ diameter for small and medium-size houses where the pressure at the main exceeds 25 lb. per sq. in. Where the pressure is less than 25 lb. per sq. in. the size of the pipe should be increased to $\frac{3}{4}''$. It is generally advisable to use $\frac{3}{4}''$ on account of diminished bore through deposits, etc. The main pressure in towns is normally between 40 lb. and 80 lb. per sq. in. Workshops or factories should have metered supplies of the size required to give the necessary quantities within working hours, an ample margin being provided for extensions. For hotels accommodating up to 350 persons a 2″ metered supply would be required : for offices containing 100 persons a 1″ pipe would be ample. In all cases the Water Company, Council, Board, etc., who supply water should be consulted.

In normal circumstances every house should have a separate service from the main, although the most recent Act of Parliament (the Water Act, 1945) admits certain exceptions. In the area of the Metropolitan Water Board, they alone have the right to lay communication pipes (Section 4 of the Metropolitan Water Board Act, 1932). Outside that area, many other undertakings have a similar exclusive right, under special Acts of Parliament and the Water Act, 1945 contemplates making this practice (eventually) universal.

The Metropolitan Water Act, 1871, lays down that :—

1. The term "communication pipe" shall mean the pipe extending from the district pipe or other supply pipe up to the stop valve fixed near to or at its point of entrance into the building.
2. Every "communication pipe" and every pipe external to the house and through the external walls thereof laid in connexion with the water of the Company, shall be of lead, and every joint shall be "wiped."
3. Every pipe when laid in open ground shall be at least 2′ 6″ below the surface and shall in every exposed situation be properly protected against the effects of frost.
4. The weights of the lead pipes shall be as shown in the following Table :—

Internal diameter of pipe in in.	Weight of pipe in lb. per lineal yd.
$\frac{3}{8}$	5
$\frac{1}{2}$	6
$\frac{5}{8}$	$7\frac{1}{2}$
$\frac{3}{4}$	9
1	12
$1\frac{1}{4}$	16
$1\frac{1}{2}$	24
2	30

Note.—The responsibility for the installation, repair and renewal of the communication pipe, including any excavation of the roadway or footpath, rests with the building owner.

LAGGING

All pipes in exposed positions should be lagged with a suitable insulating material. This applies particularly to pipes in roof spaces. Damage by frost may be avoided by keeping water pipes on the internal walls of houses as far as possible. (See page 79.)

PIPES : MATERIALS

(See List of British Standards, page 175.)

FOUNTAINS

(See Regulation on "Supply of water to aquarium fish tanks, fountains or for any ornamental purpose"—Metropolitan Water Board.)

The Metropolitan Water Board will supply a $\frac{1}{2}''$ inlet union provided with a nozzle in which a disc is inserted. The disc will be regulated to pass the required quantity of water in 24 hours, and no other connexion or supply will be allowed. A screw-down stop-cock must be fixed near the tank to control the supply to the disc only, and the pipe supply to the tank should be of lead of regulation weight. The disc reduces the height of the water jets considerably. The Board, however, allows as an alternative the installation of a meter, suitably protected, which obviates the reduction of pressure.

WEED KILLERS

Considerable research has recently been done on the effect of certain chemicals used as weed killers, more particularly on types which may be used for selective destruction of difficult weeds such as nettles and bracken growing in crops and for the eradication of other varieties of weed from paths, roads and railways.

Efficient weed killers have hitherto been almost entirely arsenical, and consequently dangerous and poisonous. Certain tar preparations are available, but the main interest now centres on the use of chlorates—which may be diluted with other materials to reduce the fire risk, or merely to simplify spreading, and on the so-called "hormone" weed-killers, the most familiar of which are phenoxyl and methoxone. These are applied by dusting.

Chlorates may be applied either dry or in solution, and have been found completely to eradicate bracken, broom, dandelions, plaintains and fescues in pasture without damage to bents or clover. It is not advisable to apply them in hot dry weather ; a damp atmosphere is preferable, but the results will not be satisfactory if heavy rain immediately

follows. In dealing with paths between lawns it is not safe to spray within 2″ to 4″ of the grass verge, as the chlorates will spread up to this distance ; but it is possible to work close to the verge if it is protected with a piece of wood or metal strip embedded an inch or so in the ground, providing the lawn is above and not below the path level. It should be carefully noted that clothing should not be wetted with the solution ; not because the clothes will be destroyed, but because they will become very highly inflammable on drying. Any wetted clothing should, therefore, be washed out afterwards or destroyed.

Sulphuric acid has recently been used as an alternative, but generally only for weed eradication in corn crops. It is not easy to apply, and a special spraying plant is required ; but it is suggested that waste acid available from accumulators or other sources might well be utilised for the purpose. It is only necessary to apply sufficient liquid to damp the surface of the weed leaves.

WEIGHTS OF MATERIALS

BUILDING STONES

The following table gives weights of the better known building stones found in the British Isles :—

Stone	Weight in lb. per cu. ft.
Ancaster Freestone	141
Ancaster Weatherbed	150·5
Anston	134
Bath (General)	128
Bath (Monks Park and Hartham Park)	137
Beer	132
Blaxter	128
Blue Pennant	172
Bolton Wood	146
Bramley Fall (Pool Bank)	142
Bramley Fall (Horsforth)	163
Casterton	129
Chilmark	135
Clipsham	150
Corsehill	141
Craigleith	139
Darley Dale	150
Doulting	135
Forest of Dean	150
Granite (Scottish)	160–175
Granite (Cornish)	165
Green Quarella	136
Ham Hill	131
Hopton Wood	153
Hollington (Average)	130
Hornton	112
Howley Park	140
Idle Stone	144
Kentish Rag	166
Ketton	157
Leckhampton	140
Leoch	153
Portland (Average)	136
Purbeck (Freestone)	150
Purbeck (Thornback)	169
Red Mansfield	143
Robin Hood	145
Weldon	120·5

TIMBERS

1. The following list, giving the weights per cu. ft. of timbers, has been compiled from data and records at the Forest Products Research Laboratory, Princes Risborough.
2. There is an appreciable range of variation in density in all species, but it has been considered sufficient to give an average figure. The weights of those species which are known to vary to an unusual extent have been marked with an asterisk.
3. Weights per cu. ft. are given for the timbers in the green condition and for an air-dry condition corresponding to a moisture content of 15 per cent.

	Green weight in lb. per cu. ft.	Air-dry Weight at 15 % moisture content
Ash	52	44
Beech	64	48
Birch (Canadian)	58	44
Black Bean	—	49
Cedar, Western Red (B.C.)	30	24
Chestnut (Sweet)	65	35
Douglas fir (B.C.)	37	33
Ebony	—	74
Elm (Common or Dutch)	66	35
Greenheart	83*	67*
Gurjun	62	46
Hemlock, Western	44	31
Indian Silver Greywood	54	43
Indian Laurel	68*	54*
Jarrah	68	56
Karri	72	59
Larch	45	37
Mahogany (Honduras)	45	34
,, (Sapele)	56*	41*
,, (Spanish)	—	43
Oak, American white	62	48
,, English	67	45
,, Silky	—	38
Padauk, Andaman	—	49
,, Burma	—	53
Pine, Kauri (N.Z.)	49	38
,, (Longleaf, pitch)	52	41
,, Red (American) / ,, Red (Canadian)	45	33
,, Scots	50	33
,, Siberian	—	26
,, Western white (Canadian and U.S.A.)	38	28
,, Yellow (Quebec)	43	26
Spruce, Black (E. Can. and U.S.A.)	36	31
,, European	42	29
,, Red (E. Can. and U.S.A.)	35	29
,, Mountain (B.C.)	37	28
,, Sitka (W. Can. and U.S.A.)	32	28
Teak (Burma and Indian)	55	41
,, (Iroko, W.A.)	63	41
Walnut (Black)	58	41
,, (European)	51	41
,, (Queensland)	—	46
Whitewood (Baltic)	56	43

METALS

	lb. per cu. ft.		lb. per cu. ft.
Aluminium	167	Iron, wrought ...	480
Brass, cast	524	Lead, commercial ...	715
„ rolled ...	534	Steel	490
Bronze (average) ...	535	Tin	455
Copper, sheet ...	558	Zinc, sheet	445
Iron, cast	450	Zinc, cast	436

Weight in lb. of Copper and Brass sheet per ft. super.

B.W.G.	Copper	Brass	I.S.W.G.	Copper	Brass
20	1·78	1·69	20	1·67	1·60
21	1·62	1·54	21	1·48	1·42
22	1·45	1·37	22	1·30	1·24
23	1·30	1·23	23	1·11	1·06
24	1·16	1·10	24	1·02	·97
25	1·04	·99	25	·93	·89
26	·92	·88	26	·83	·80
27	·83	·79	27	·76	·72
28	·74	·70	28	·68	·65
29	·64	·61	29	·63	·60
30	·58	·55	30	·57	·55

Note.—For difference between gauges, see under "Wire Gauge," page 157.

AVERAGE WEIGHTS OF BUILDING MATERIALS

(See also B.S. 648 "Unit Weights of Building Materials.")
Note.—The following are good average figures. Some variation is inevitable in most cases, and particular care must be taken in connexion with those materials which show a wide variation in wet and dry conditions.

Material	lb. per sq. ft.		
Asphalt, 1″ thick		11·00	
Asbestos cement corrugated sheeting, ¼″ thick (as laid)		3·50	
Asbestos cement flat sheeting ¼″ as laid		2·30	
Asbestos cement slating 3/16″ as laid			
diamond pattern		2·90	
rectangular pattern		4·10	
Blocks (Hollow, Partition) :—			
Clay, per 1″ overall thickness of block as laid		5·25	
Concrete, per 1″ overall thickness of block as laid ...		5·25	
Diatomaceous Earth, per 1″ thickness of block as laid ...		2·5	
Boards :—			
Fibre (½″ thick)		0·75	
Plaster Cored (⅜″ thick) ...		2·00	
„ „ (⅜″ thick) plus setting coat		3·00	
Boarding to slate or tile roofs, per 1″ thickness		2·50	
Bricks (Laid in cement mortar 1 to 3)	Dry Brickwork 4½″	9″	13½″
"Common" or Light such as "London Stock," Fletton and including Sand lime bricks (125 lb. per cu. ft.)	47	94	141
Glazed Bricks (130 lb. per cu. ft.)	49	98	147
Heavy Pressed Bricks (Blue or Red Engineering at 140 lb. per cu. ft.)	52	104	156
Concrete, Mass 1 : 8 mix per in. thickness		11·70	
Concrete Reinforced 1 : 2 : 4 mix per in. thickness		12·00	
Concrete screeding, per in. thickness (1 to 3 mix)		12·00	
Copper Roofing (24 S.W.G.) laid with rolls and laps, etc. ...		1·50	
Cork slabs, 1″ thick		1·00	
Flooring :—			
Hardwood, e.g., oak or Maple ⅞″ finished thickness ...		3·30	
Softwood (Redwood, Whitewood, etc.) ⅞″ finished thickness		2·30	
Rubber ¼″ thick		2·30	
Magnesium Oxychloride per 1″ of thickness (sawdust filler)		7·50	
Glass per ¼″ thickness		3·50	
Glazed Roofing (with ¼″ glass and lead covered steel bars at 24″ centres)		6·00	
Glazed Pavement and Roof Lights (about 2½″ thickness)		25·00	
Thatch (Reed) 12″ thick (nominal) including battens		8·50	
Tiling—Plain roof laid 4″ gauge (machine made)		13·00	
Ditto (hand made)		14·50	
Pan, Roman and Marseilles tiles		7·50	
Lead roofing 6 lb. as laid with rolls and drips, etc.		8·00	
Plaster ¾″ thick with metal or wood lathing		8 to 10	
Ditto Fibrous ⅜″ thick (as fixed) ...		3·00	
Slating 3″ lap. First, second, rough	5·00	5·60	8·10
Steel sheeting, galvanised, corrugated including laps :— ...			
16 : 18 : 20 gauge	3·85	2·84	2·22
22 : 24 : 26 gauge	1·92	1·50	1·30
Terrazzo paving, 1″ thick ...		10·40 to 12·40	
Tiling :—			
Plain roof, as laid ...		18	
Pan roof, as laid		12	
Rubber, per 1″ thickness ...		4·00 to 5·00	
White earthenware wall, ¼″ thick exclusive of bedding... ...		2·28	
White earthenware wall, ⅜″ thick exclusive of bedding... ...		3·44	
Floor tiles as laid per ½″ thickness		5·80	
Wood floor battens, 2″ × 2″ deal at 14″ centres		0·85	
Wood joists 2″ thick at 14″ centres per in. depth		0·43	
Zinc roofing (No. 15 zinc gauge) with rolls and drips, and turnups as laid		1·75	

WEIGHT OF ROOF TRUSSES

The following empirical formula for the weight of steel roof trusses of 30° pitch gives reasonably accurate results.

Where W = weight of the truss in lb. per sq. ft. of plan area.

D = distance apart centre to centre of trusses.

S = span of truss.

For slate covered roofs with felt, boarding and battens,

$$W = \frac{D}{12\cdot5} \times \frac{S}{17}$$

For heavy tiles with felt, boarding and battens, increase the above weights by 20 per cent.

The weights of steel trusses of any other pitch than 30° must be modified in the ratio of the lengths of the principal rafters. To obtain the ratio first work out the length of the principal rafter for the given span but pitch of 30°; then length of principal rafter for given pitch (See Ex. (2).)

Ex. (1) Pitch 30°. Span 60′. Distance apart of trusses 14′. Covering; slate, felt boarding and battens.

$$W = \frac{14}{12\cdot5}(60 \div 17) = 3\cdot95 \text{ lb. per sq. ft.}$$

For heavy tiles this would be :—

$$3\cdot95 \times \frac{120}{100} = 4\cdot74 \text{ lb. per sq. ft.}$$

Ex. (2) Pitch 45° but other conditions as for Ex. 1. For a span of 60′ and pitch of 30° the length of the principal rafter is 34·6′. The same span but 45° pitch gives the length of the principal rafter as 42·4.

$$\text{Hence } W = \frac{42\cdot4 \times 3\cdot95}{34\cdot6} = 4.85 \text{ lb. per sq. ft.}$$

WEIGHTS OF MERCHANDISE

(As packed and stacked)

	Weight in lb. per cu. ft. of space occupied
TEXTILES, ETC.	
Wool in bales (compressed)	48
„ „ (not compressed)	29 to 15
Woollen flannels in cases	22
„ blankets „	13
Cotton in bales (compressed)	25
„ bleached goods in cases	28
„ prints and burlaps	30
„ tickings in bales	37
Linen damask in cases	50
„ goods „	30
„ towels „	40
Hemp in bales (compressed)	22 to 30
Jute „ „ „	41
Sisal „ „ „	24
Tow (compressed)	29
PAPER	
Newspaper and strawboard	35
Writing and calendered paper	64
Wrapping paper	10 to 20
Manila	37
GRAIN	
Wheat (in bags)	40 (in bulk 43)
Barley „	39 (in bulk 41)
Oats „	30 (in bulk 33)
Hay and straw in bales (compressed)	20 to 24

	Weight in lb. per cu. ft. of space occupied
GROCERIES	
Beans (in bags)	40
Coffee, roasted (in bags)	35
Rice (in bags)	58
Salt (in bags)	70 (loose 48)
Sugar (in barrels)	43
„ (in cases)	51
Cheese	30
Flour in barrels	40
Starch „	25
Treacle	48
Wines and liquors in barrels	38
Canned goods in cases	58
Dates in cases	55
Figs in cases	74
Soap powder in cases	38
Soap Bars in cases	56
Tea in chests	25
Oil in barrels	36
HARDWARE	
Hinges	64
Locks packed in cases	31
Screws	101
Sheet tin in boxes	278
Insulated copper wire in coils	63
Galvanized iron wire in coils	74
Glass in boxes	60
Crockery in crates	40
Crockery in casks	14
Leather and hides in bales	20
Leather in bundles	37
Rope (in coils)	32
PAINTS, ETC.	
Linseed oil in barrels	36
„ „ drums	45
Red lead and litharge, dry	132
White lead paste in cans	174
„ „ dry	86
Gum Shellac	38
Resin in barrels	48
Caustic soda (in iron drums)	88
Pearl alum (in barrels)	33
Blue Vitriol (in barrels)	45
Glycerine, in cases	52
Soda silicate in barrels	53
Sulphuric Acid (87 per cent)	112
Sulphur	125

MISCELLANEOUS MATERIALS

In lb. per cu. ft.

Cement, Portland	90	Limestone and marble	168
Clinker	85	Slate	160–180
Coal anthracite broken	56	Snow freshly fallen	5–12
„ „ solid	80	„ moistened and compacted	15–20
„ broken loose	50	Tar	63
Coke, loose	28	Turf or peat unpressed	23–30
„ solid	84	Water	62·4
Flint	162		
Lime	64		

WELLS

The terms deep and shallow, as applied to wells, have different meanings depending upon whether they are used from a geological or engineering point of view. The geological definition of a shallow well is one tapping water in a sand or gravel bed above impervious strata, irrespective of actual depth ; the deep well, by the same classification, is one tapping water from below impervious strata. The engineer, classifying wells according to the type of pump required, defines a shallow well as one from which the water may be removed by means of a direct acting suction pump, i.e., the water level is not more than about 22′ below the surface, and a deep well as one requiring the use of a deep well pump, i.e., one lowered into the well casing to below water rest level, which is beyond the range of a direct acting surface pump. The latter well is more usually referred to as a bore-hole, since it is more frequently bored than dug.

ARTESIAN WELLS

The true Artesian well is one situated in low-lying country, but tapping the water whose rest level is higher than the ground level at the well. This type of well should, therefore, supply without pumping. The term, however, has become abused and is applied loosely to wells which are bored and tubed in addition to those conforming to the correct definition.

Deep wells and Artesian wells are generic terms given to any bore, the water level of which is beyond the suction range of an ordinary surface pump.

Modern deep wells are lined with wrought iron or steel tubes which are carried to a point below the lowest water rest level. In such cases the pump barrel is placed in the bore hole lower than the standing level of water, so that it is always flooded for starting work. The barrel should be 1″ to 1½″ less in diameter than the lining tube, and screwed to the rising main (delivery pipe). The latter should be slightly larger than the barrel to allow the pump bucket, with the bottom valve, to be withdrawn for examination or repair. The pump rods, driven by a suitable machine at the head of the bore, pass through the rising main and terminate in the pump bucket and valves. These rods are articulated in suitable lengths and the joints are detachable, allowing for withdrawal and replacement at will.

Deep well pumps should be run at slow speeds and the varying duty on the driving gear, due to the different conditions of the up and down strokes, should be distributed by means of suitable equalising or balance gear.

Pumps are usually driven by means of a crank on a second motion shaft, suitably connected through reduction gear to the shafting, electric motor or engine by means of a belt and fast and loose pulleys.

STEINING

All wells should be steined, i.e., lined, to prevent the sides falling in, and the method and thoroughness of the steining depends on the strata through which the bore passes. Shallow wells are usually of the dug type and of comparatively large diameter, and the thickness of the steining depends on the diameter, depth of well and firmness of the surrounding ground. Normally, 9″ brickwork is sufficient for diameters up to 8′, and 14″ brickwork for diameters up to 14′—with an additional 4½″ for bad soils. To prevent surface water and near-by springs penetrating into the well, the back of the steining should be filled with clay puddle or concrete. Where practicable the following conditions should be observed :—The area surrounding a well, to a radius of 10 to 12 yds., should slope away from the mouth and be waterproof-paved or concreted—to make certain that the surface water must pass through a large body of earth before being able to percolate through to the well, or even to the back of the steining. A well should not be near any form of drain or sewer, a general rule being that the separation should be 4′ to 5′ for every ft. of depth, i.e., a 20′ well should be 80′ to 100′ from the nearest drain. Cesspools or cemeteries should not be nearer than 150 to 200 yds. to a shallow well, generally speaking ; but the actual safe distance must in all cases be dependent on the nature of the ground, dip of the strata, etc.

PUMPS FOR SHALLOW WELLS

These are usually of the manual type and should have a discharge capacity not exceeding 25 gallons per minute, against a total head, i.e., suction plus delivery, of 30′.

This duty is obtainable with a pump having a 10″ stroke and a 4″ bore, and is as much as one man can reasonably manage. The theoretical maximum depth from which a plunger pump will draw liquid is approximately 30′ ; but the practical maximum, allowing for leaky joints, glands or defective foot-valve, etc., is nearer 22′, and this figure should not be exceeded when making calculations.

A windlass and bucket should never be provided for a well if any of the water is intended for human consumption, as this precludes the possibility of properly covering the top. In the case of a dug well, the water level of which is beyond the suction lift of an ordinary pump, the installation of an elevator should be considered. This consists of an endless band, to which is fixed a series of metal cells, the whole kept in tension and submerged by a weighted band pulley. For manual operation the output is about 13 gallons per minute from a depth of 50′ ; but equipments may be obtained for much larger outputs intended for operation by any suitable power plant.

Submersible electric pumps, also, are cheap and convenient where power is available.

AIR LIFT

As an alternative to the bore hole pump, deep well water may be raised by means of a compressed air lift : such a system, however, should not be installed without expert advice as the efficiency falls off considerably at great depths. In this system, compressed air of suitable volume is admitted to the bottom of a pipe immersed in the bore, well below standing water level. Alternate plugs of air and water are formed in the rising pipe, and this column is discharged into the surface tanks.

WIRE GAUGE

SHEET AND WIRE GAUGE

For all metals and wires except sheet zinc and lead. Weights given in table are for steel only.

" B.G." (Birmingham Gauge) has long been the customary British commercial gauge for iron or steel sheets, whether black, tinned or galvanised and also for hoops.

4-B.G. is ¼″, 10-B.G. ⅛″, 16-B.G. $\frac{1}{16}$″, and for every addition of 6 to the gauge number, the thickness is halved. " I.S.W.G." (Imperial Standard Wire Gauge), was established in September, 1883, and is used for wire, electrodes, boiler tubes, etc. To obtain weights of iron sheet and wire, deduct 2 per cent from the weights of steel given below.

BIRMINGHAM AND IMPERIAL WIRE GAUGES

Gauge No.	B.G. Thickness		B.G. Weight per sq. ft.	I.S.W.G. Thickness		I.S.W.G. Weight: Wire per 100 yds.	I.S.W.G. Weight: Sheets per sq. ft.
	in.	mm.	lb.	in.	mm.	lb.	lb.
1	·353	8·97	14·41	·300	7·62	72·0	12·24
2	·315	7·99	12·84	·276	7·01	61·0	11·26
3	·280	7·12	11·44	·252	6·40	50·8	10·28
4	·250	6·35	10·20	·232	5·89	43·1	9·47
5	·222	5·65	9·08	·212	5·38	36·0	8·65
6	·198	5·03	8·08	·192	4·88	29·4	7·83
7	·176	4·48	7·20	·176	4·47	24·8	7·18
8	·157	3·99	6·41	·160	4·06	20·4	6·53
9	·140	3·55	5·70	·144	3·66	16·6	5·87
10	·125	3·17	5·10	·128	3·25	13·1	5·22
11	·111	2·83	4·54	·116	2·95	10·8	4·73
12	·099	2·52	4·04	·104	2·64	8·63	4·24
13	·088	2·24	3·60	·092	2·34	6·76	3·75
14	·078	1·99	3·20	·080	2·03	5·11	3·26
15	·070	1·77	2·85	·072	1·83	4·15	2·94
16	·062	1·59	2·55	·064	1·63	3·29	2·61
17	·056	1·41	2·27	·056	1·42	2·50	2·28
18	·049	1·26	2·02	·048	1·22	1·83	1·96
19	·044	1·12	1·79	·040	1·02	1·27	1·63
20	·039	·996	1·60	·036	·914	1·03	1·47
21	·035	·886	1·42	·032	·813	·819	1·31
22	·031	·794	1·27	·028	·711	·628	1·14
23	·028	·707	1·13	·024	·610	·461	·979
24	·025	·629	1·01	·022	·559	·387	·898
25	·022	·560	·899	·020	·508	·320	·816
26	·020	·498	·800	·018	·457	·259	·734
27	·017	·443	·712	·016	·417	·215	·669
28	·016	·397	·637	·015	·376	·175	·604
29	·0139	·353	·567	·0136	·345	·148	·555
30	·0123	·312	·502	·0124	·315	·123	·506
31	·0110	·279	·449	·0116	·295	...	·473
32	·0098	·249	·400	·0108	·274	...	·441
33	·0087	·221	·355	·0100	·254	...	·408
34	·0077	·196	·314	·0092	·234	...	·375
35	·0069	·175	·282	·0084	·213	...	·343
36	·0061	·155	·249	·0076	·193	...	·310
37	·0054	·137	·220	·0068	·173	...	·277
38	·0048	·122	·196	·0060	·152	...	·245
39	·0043	·109	·175	·0052	·132	...	·212
40	·0039	·098	·157	·0048	·122	...	·196
41	·0034	·087	·140	·0044	·112	...	·180
42	·0031	·078	·125	·0040	·102	...	·163
43	·0027	·069	·111	·0036	·091	...	·147
44	·0024	·061	·099	·0032	·081	...	·131
45	·0021	·055	·088	·0028	·071	...	·114
46	·0019	·049	·078	·0024	·061	...	·098
47	·0017	·043	·069	·0020	·051	...	·082
48	·0015	·039	·062	·0016	·041	...	·065
49	·0013	·034	·055	·0012	·030	...	·049
50	·0012	·030	·049	·0010	·025	...	·041

WORK BY LOCAL AUTHORITIES AND OTHER STATUTORY BODIES

Where building and other schemes include items of work which actually are to be carried out by a local authority or other statutory body, on behalf, and at the expense of the building owner, it is advisable to obtain from the local authority or other body concerned, an estimate of the cost, and to insert the appropriate figure as a " Provisional Sum " in the Specification and/or Bill of Quantities, rather than to insert an unpriced item, and leave it for the contractors themselves to obtain a figure.

This applies to drain connections to sewers, carriage way crossings, etc., connections in respect of water, gas and electricity.

IMPERIAL STANDARD WIRE GAUGE

TABLE OF SIZES, WEIGHTS, LENGTHS AND BREAKING STRAINS OF STEEL WIRE

Size on Wire Gauge	Diameter: Decl. of an in.	Diameter: Millimetres	Sectional area in sq. in.	Approximate weight of: 100 yds.	Approximate weight of: Mile	Approximate weight of: Kilometre	Approximate length of: Cwt.	Approximate length of: 100 Kilos	Approximate breaking strain: 25 tons per sq. in.	Approximate breaking strain: 35 tons per sq. in.
				lb.	lb.	lb.	yds.	yds.	lb.	lb.
7/0	·500	12·7	·19635	200·11	3522	2188	56	110	10995	15393
6/0	·464	11·8	·16910	172·33	3033	1885	65	128	9469	13257
5/0	·432	11·0	·14657	149·37	2629	1634	75	147	8208	11490
4/0	·400	10·2	·12568	128·07	2254	1400	87·5	172	7035	9851
3/0	·372	9·4	·10869	110·80	1950	1211	101	198	6086	8521
2/0	·348	8·8	·09510	96·93	1706	1060	115	226	5326	7457
1/0	·324	8·2	·08244	84·03	1479	919	133	261	4616	6463
1	·300	7·6	·07069	72·04	1268	788	155	305	3958	5542
2	·276	7·0	·05982	60·97	1073	667	183	360	3350	4690
3	·252	6·4	·04987	50·85	895	556	220	433	2792	3910
4	·232	5·9	·04227	43·07	758	471	260	512	2366	3313
5	·212	5·4	·03530	35·97	633	393	311	612	1977	2767
6	·192	4·9	·02896	29·43	518	323	380	748	1621	2269
7	·176	4·5	·02432	24·77	436	271	452	890	1362	1908
8	·160	4·1	·02011	20·45	360	224	546	1075	1125	1576
9	·144	3·7	·01628	16·59	292	182	675	1329	911	1276
10	·128	3·3	·01287	13·12	231	143	854	1681	720	1008
11	·116	3·0	·01057	10·80	190	118	1040	2047	592	828
12	·104	2·6	·00850	8·63	152	95	1293	2545	475	666
13	·092	2·3	·00665	6·76	119	74	1653	3254	373	521
14	·080	2·0	·00503	5·11	90	56	2186	4303	281	394
15	·072	1·8	·00407	4·15	73	45	2699	5313	227	318
16	·064	1·6	·00322	3·29	58	36	3416	6724	180	252
17	·056	1·4	·00246	2·50	44	27·5	4462	8783	138	192
18	·048	1·2	·00181	1·83	32·5	20·2	6073	11954	101	141
19	·040	1·0	·00126	1·27	22·54	14·0	8745	17214	70	98
20	·036	0·9	·00102	1·03	18·25	11·34	10796	21251	57	79
21	·032	0·8	·00080	·819	14·42	8·96	13663	26894	45	63
22	·028	0·7	·00062	·628	11·04	6·86	17846	35128	34·4	48·2
23	·024	0·6	·00045	·461	8·11	5·04	24290	47813	25·2	35·3
24	·022	0·55	·00038	·387	6·82	4·24	28908	56903	21·2	29·8
25	·020	0·5	·00031	·320	5·63	3·5	34978	68851	17·6	24·6
26	·018	0·45	·00025	·259	4·56	2·84	43184	85003	14·2	19·9
27	·0164	0·4	·00021	·215	3·79	2·35	52021	102498	11·8	16·6
28	·0148	0·37	·00017	·175	3·09	1·92	63877	125735	9·6	13·5
29	·0136	0·35	·00014	·148	2·61	1·62	75646	148903	8·1	11·4
30	·0124	0·32	·00012	·123	2·17	1·35	90996	179118	6·8	9·5

WAR DAMAGE COMMISSION, REGIONAL OFFICES :

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North Midland : Lucknow Road, Nottingham. Nottingham 6072.

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Southern : Coley Park, Reading. Reading 4827.

South Western : 4, Worcester Road, Clifton, Bristol. Bristol 34096.

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Midland : Viceroy Close, Bristol Road, Birmingham 5. Calthorpe 3161–6.

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N. Ireland : 27, Great Victoria Street, Belfast. Belfast 27891.

ZINC

The chief application of zinc in building today is in the form of rolled sheet zinc for roofing, weatherings and rainwater goods. The best known property of zinc is its excellent resistance to corrosion in normal outdoor atmospheres. In sheet form it has been widely used for roofing for nearly a century, its slow and even corrosion making it particularly suitable for this purpose.

On exposure to the atmosphere, zinc forms its own protective coating, which is a basic carbonate. This coating is very tenacious and having the same co-efficient of expansion as the metal itself, does not tend to flake off with changes in temperature. Once it is formed, it is generally accepted that the rate of corrosion is uniform. Thus, in general, the life of the zinc, whether in sheet form, or as a protective coating, may be said to be proportional to its thickness. Under urban conditions, such as in most parts of London, zinc sheet 0·031″ thick (No. 21 I.S.W.G., No. 14 Z.G.), when laid by competent workmen, has been found to have an effective life of 40 years or more as a roof covering, requiring no repair except in cases of mechanical damage. The resistance of zinc to marine atmospheres is excellent, and evidenced by its wide and successful application for roofing and other purposes on pier pavilions. It is not suitable for use in heavily polluted atmospheres, such as prevail at certain chemical plants. Furthermore, zinc should not be used in contact with copper in positions where electro-chemical action could take place. The corrosion products of copper should not be discharged on to zinc.

The English stock sizes of zinc sheets used for roofing purposes are 3′ wide and 7′ and 8′ long. Other size sheets are obtainable for special orders, but usually at slightly increased cost. The life of a zinc roof depends upon the thickness of zinc used. It is not satisfactory to use zinc thinner than No. 14 gauge for general work, and for special work a heavier gauge is recommended. The zinc gauge rises in number with thickness, and must not be confused with the Imperial Standard Wire Gauge. Below are given the details of this gauge for sheets applicable to roofing work.

TABLE SHOWING THE WEIGHTS OF VARIOUS GAUGES OF ZINC SHEETS

Based on 1 sq. ft. × 1″ thick = 37·456 lb. (Sp. Gr. 7·2)

Zinc Gauge No.	Approx. Weights per sq. ft. in oz.	Thickness in decimals of an in.	7′ × 3′ Approximate Weight per sheet	7′ × 3′ No. of sheets in 20 cwt.	8′ × 3′ Approximate Weight per sheet	8′ × 3′ No. of sheets in 20 cwt.	Nearest Imperial Standard Wire Gauge
			lb. ozs.		lb. ozs.		
12	14·98	·025	19 11	114	22 8	100	23
13	16·78	·028	22 —	102	25 3	89	22
14	18·58	·031	24 6	92	27 14	80	21
15	21·57	·036	28 5	79	32 6	69	20
16	24·57	·041	32 4	69	36 14	61	19

Several systems of zinc roofing are used in this country, the chief being the roll cap system (to British Standard 849) which, in spite of many minor alterations, has remained fundamentally the same for nearly a hundred years. By this system roofs can be laid without the use of solder except for a few minor details and can be fixed without nails or screws passing through the exposed surfaces of the zinc. Expansion and contraction are also fully provided for.

The sheets are laid over boarding between wood rolls fixed in the direction of the fall. With regard to boarding, imperfectly seasoned oak and western red cedar should be avoided, since the acids present in them may possibly attack the zinc. The side edges of the sheets are turned up against the wood rolls, the rolls and turn-up edges being then covered with a zinc capping. It is not essential to use felt or building paper under the zinc, although it is certainly an advantage to do so. Felt improves the thermal insulation of the roof and also reduces the risk of damage to the metal through unevenness in the boarding, especially when the roof is subject to much traffic. It will also reduce condensation on the underside of the zinc.

On flat roofs, i.e., roofs with a pitch of less than 1 in 8, drips are used to join the sheets across the fall which should not be less than 1½″ in 8′, the drips being 2½″ deep. On pitched roofs, with a fall of more than 1 in 8, the drips are replaced by single welts which should run the full width of the sheet including all vertical turn-ups such as at rolls, walls, etc.

Corrugated zinc sheet is used in a similar manner to galvanised steel, although the supports or purlins must be placed at closer intervals than with steel. This type of roofing is most suitable for farm buildings and factories, since it lasts much longer than ordinary galvanised steel sheeting and, once fixed, requires no maintenance during the life of the metal.

Italianised zinc roofing is widely used on unboarded roofs, such as dock warehouses and sheds, coverings over station platforms and staircases. The sheets are formed with three corrugations in the width of the sheet, one on each outer edge and one in the centre, the corrugations being spaced at 1′ 3″ centres. Each corrugation is supported by a bearer fixed to the roof purlin. This type of roofing can be applied also to close-boarded roofs where it will improve both the thermal and sound insulation.

Eaves, gutters and rainwater pipes are widely used in some districts. As with zinc roofing, the life of these gutters depends largely on the thickness of the zinc used, not less than No. 12 Z.G. being recommended. The most popular sections, which are obtainable in 7′ and 8′ lengths and in various sizes, are the ogee, the half-round and the rectangular. All gutters should be stayed with tubular zinc stays soldered into them at not more than 1′ 3″ centres. The ogee and rectangular sections are fixed by screwing through the stays into the fascia board with large, heavily galvanised mushroom head screws of mild steel. Gutters are screwed at every alternate stay. Such gutters, of No. 12 Z.G. and over are strong and rigid and when strengthened with zinc stays, will stand up to normal usage, e.g., painters' ladders, etc. Half-round gutters are stayed in the same manner but must be supported and fixed with galvanised mild steel brackets. Gutter lengths are joined by lapping one into the other in the direction of the fall and soldering inside. Solder is also used for fittings such as mitres, stop-ends and socket pieces.

Rainwater pipes are rolled from the flat sheet and joined with a seam up the back of the pipe. This seam can be either soldered or, preferably, grooved and locked. A British Standard is being issued for zinc rainwater goods and will be available shortly.

STANDARD TECHNICAL BOOKS & REFERENCES

The following book-list does not claim to be comprehensive, nor does it include works on the Art and History of Architecture. The volume of official literature on building construction and housing is now so large that it has been thought advisable to list official publications separately. Reference should also be made to the sections on British Standards on p 169. and Codes of Practice on p. 177.

Under present conditions, it is likely that many of the books listed will be unobtainable. Where a book is definitely known to be out of print at the time of going to press the fact is indicated by the letters O.P. In many cases also, new editions may have appeared for some books listed, at higher prices than those indicated for earlier editions.

Foreign books have not been included, nor have references to periodical literature.

STANDARD TECHNICAL BOOKS

The following list is a selection only of titles on the various subjects, with emphasis on more recent books. The dates and prices given are those of the last known editions.

PROFESSIONAL PRACTICE

H. I. Ashworth. *Architectural Practice and Administration.* (Pitman.) 1933. 12s. 6d.

A. Brice. *The Law Relating to the Architect.* (Stevens.) 1925. 10s. 0d.

O. Brown. *Architects' Accounts.* (Gee.) 1934. 7s. 6d.

H. B. Creswell. *The Honeywood File.* (Architectural Press.) 1929. O.P.

The Honeywood Settlement. (Architectural Press.) 1930. O.P.

Sir B. Fletcher. *Arbitrations.* (Batsford.) 1925. 10s. 0d.

F. R. Reekie. *Draughtsmanship.* (Arnold.) 1946. 10s. 6d.

H. H. Turner. *Architectural Practice and Procedure.* (Batsford.) 1931. 15s. 0d.

BUILDING LAW

H. R. Chanter. *London Building Law, an Introduction and Guide.* (Batsford.) 1946. 21s. 0d.

W. T. Creswell. *The Law Relating to Dilapidations.* (*The Builder.*) 1936. 6s. 0d.

B. P. Davies. *Building Laws, Byelaws and Regulations.* (Building Estimator.) 1938. 25s. 0d.

T. P. Frank. *Knight's Annotated Model Byelaws.* (Knight.) 1942. 30s. 0d.

S. P. Hayward. *The Law of Dilapidations.* (*Estates Gazette.*) 1936. 12s. 6d.

Knight's Public Health Statutes. (Knight.) 30s. 0d.

L.C.C. Construction of Buildings in London. (King and Staples.) 1938. 5s. 0d.

W. Robertson, C. Porter and J. Fenton. *Sanitary Law and Practice.* (Sanitary Publishing Co.) O.P.

S. Swift. *Housing Administration.* (Butterworth.) 1938. 27s. 6d.

ESTIMATING AND COSTING

J. H. Anderson. *Building Quantities.* (Arnold.) 1946. 7s. 6d.

B. P. Davies. *Estimating for Buildings and Public Works.* (Educational Publishing Co.) 1927. O.P.

Specification for Houses. (Building Estimator Publications.) 1945. 15s. 0d.

F. E. Drury and G. Doyle. *Quantities in Architectural Building Construction.* (C.U.P.) 1934. 6s. 6d.

Joint Committee. *Standard Methods of Measurement of Building Works.* (Chartered Surveyors Inst.) 1935. 7s. 6d.

S. Geddes. *Building and Public Works Administration, Estimating and Costing.* (Newnes.) 1946. 25s. 0d.

Laxton's Builders Price Book. (Kelly.) Ann. 10s. 6d. (Last issue 1940, O.P.)

H. A. Mackmin. *Builders' Estimates and Pricing Data.* (Chapman and Hall.) 1936. 12s. 6d.

R. T. Rea. *How to Estimate.* (Batsford.) 1941. 16s. 0d.

J. S. Smith. *Building Specifications.* (Hutchinson.) 1946. 16s. 0d.

REPAIRS TO BUILDINGS

W. Frost. *Bricklayers Repair Work.* (Technical Press.) 1944. 4s. 6d.

A. G. Geeson. *General Building Repairs.* (Virtue.) 1942. 3 vols. 63s. 0d.

A. R. Powys. *The Repair of Ancient Buildings.* (Dent.) 1929. O.P.

GENERAL BUILDING CONSTRUCTION

Architectural Press. *Specification.* Annual. 15s. 0d.

Burnet Tait and Lorne. *Information Book.* (Architectural Press.) 1933. 25s. 0d.

Library of Planned Information. (Architectural Press.) 5 vols. 21s. 0d. each.

E. G. Blake. *Damp Walls.* (Technical Press.) 1938. 7s. 6d.

P. D. Close. *Building Insulation.* (Technical Press.) 1946. 24s. 6d.

R. Fitzmaurice. *Principles of Modern Building,* Vol. I. (H.M.S.O.) 1944. 11s. 0d.

W. R. Jaggard and F. E. Drury. *Architectural Building Construction.* (C.U.P.) 1938. 3 vols. 38s. 0d.

C. F. Mitchell and G. A. Mitchell. *Building Construction and Drawing.* (Batsford.) 1938. 2 vols. 17s. 0d.

G. E. Mitchell. *Model Building Byelaws Illustrated.* (Batsford.) 1939. 10s. 6d.

F. J. Samuely and C. W. Hammann. *Building Design and Construction with reference to the New L.C.C. Regulations.* (Chapman and Hall.) 1939. 28s. 0d.

E. G. Warland. *Building Construction for National Certificate.* (English Universities Press.) 3 vols. 19s. 0d.

Post-War Building Studies, No. 18.

ACOUSTICS

H. Bagenal. *Practical Acoustics and Planning Against Noise.* (Methuen.) 1942. 7s. 6d.

A. H. Davis. *Modern Acoustics.* (Bell.) 1934. 26s. 0d.

R. Fitzmaurice and W. A. Allen. *Sound Transmission in Buildings.* (H.M.S.O.) 1945. 4s. 0d.

C. W. Glover. *Practical Acoustics for the Constructor.* (Chapman and Hall.) 1933. 25s. 0d.

P. E. Sabine. *Acoustics and Architecture.* (McGraw-Hill.) 1932.

Post-War Building Studies No. 14.

BRICKWORK

E. L. Brailey. *Brickwork.* (Pitman.) 1945. 45s. 0d.

E. Dobson and A. B. Searle. *Bricks and Tiles.* (Technical Press.) 1936. 12s. 0d.

W. Frost. *The Bonding of Brickwork.* (C.U.P.) 1933. 5s. 0d.
The Modern Bricklayer. (Caxton.) 1932. 3 vols. 75s. 0d.

N. Lloyd. *A History of English Brickwork.* (Montgomery.) 1928. O.P.

E. Molloy. *Brickwork and Masonry.* (Newnes.) 1941. 6s. 0d.

F. Walker. *Brickwork.* (Technical Press.) 1937. 3s. 0d.

Post-War Building Studies No. 15.

CONCRETE AND REINFORCED CONCRETE

H. C. Adams. *Elements of Reinforced Concrete Design.* (Concrete Publications.) 1942. 6s. 0d.

T. J. Bray. *A Course of Reinforced Concrete Design.* (Chapman and Hall.) 1946. 25s. 0d.

Concrete Year Book. Annually. (Concrete Publications.) 5s. 0d.

Concrete Surface Finishes. (Reinforced Concrete Association, Technical Paper No. 4.) 1945. 2s. 6d.

O. Faber. *Reinforced Concrete Simply Explained.* (O.U.P.) 1929. 6s. 0d.

W. H. Glanville (Ed.). *Modern Concrete Construction.* (Caxton Pub. Co.) 1939. 4 vols. £5.

R. F. B. Grundy. *The Essentials of Reinforced Concrete Design.* (Chapman and Hall.) 1939. 12s. 6d.

F. M. Lea and C. H. Desch. *The Chemistry of Cement and Concrete.* (Arnold.) 1935. 25s. 0d.

G. P. Manning. *Reinforced Concrete Design.* (Longmans Green.) 1936. 24s. 0d.

C. E. Reynolds. *Concrete Construction.* (Concrete Publications.) 1938. 15s. 0d.

W. L. Scott and W. H. Glanville. *Explanatory Handbook on the Code of Practice for Reinforced Concrete.* (Concrete Publications.) 1939. 8s. 0d.

H. N. Walsh. *How to Make Good Concrete.* (Concrete Publications.) 1939. 4s. 0d.

A. E. Wynn. *Design and Construction of Formwork for Concrete Structures.* (Concrete Publications.) 1939. 20s. 0d.

Post-War Building Studies No. 8.

DECORATION

A. G. Geeson (Ed.). *The Practical Painter and Decorator.* (Virtue.) 1937. 2 vols. O.P.

N. Heaton. *Outlines of Paint Technology.* (Griffin.) O.P.

J. Lawrance. *Painting from A to Z.* (Sutherland.) 1938, O.P.
The Painting of Buildings. (R.I.B.A. *Journal*, Jan. 1946, p. 78.)

Odhams Press. *The Practical Painter and Decorator.* (Odhams.) 1945. 9s. 6d.

D. Patmore. *Decoration for the Small Home.* (Putnam.) 1938. 5s. 0d.

W. J. Pearce. *Painting and Decorating.* (Griffin.) O.P.

Bulletins of the Paint Research Association :

16. *Preservation of Iron and Steel by means of Paint.*
22. *Preparation of Metal Surfaces for Painting.*
26. *Priming Joinery Timber.*
29. *Decoration of New Plaster and Cement.*
34. *Painting Treatment of Non-ferrous Metals.*

Post-War Building Studies No. 5.

GLASS AND GLAZING

D. M. J. Davidson. *Glass and Glazing.* (Crosby Lockwood.) 1946. 5s. 0d.

R. McGrath and A. C. Frost. *Glass in Architecture and Decoration.* (Architectural Press.) 1937. 63s. 0d.

HEATING AND VENTILATING

T. Bedford. *Modern Principles of Ventilation and Heating.* (Lewis.) 1937. 4s. 6d.

O. Faber and J. R. Knell. *Heating and Air-conditioning of Buildings.* (Architectural Press.) 1943. 25s. 0d.

A. H. Henly. *Design Problems of Heating and Ventilation.* (Crosby Lockwood.) 1935. O.P.

E. Molloy (Ed.). *Principles and Practice of Heating and Ventilating.* (Newnes.) 1944. 21s. 0d.

E. Molloy (Ed.). *Hot Water Engineering.* (Newnes.) 1945. 21s. 0d.

L. C. C. Rayner. *Questions and Answers on Heating.* (Newnes.) 1946. 5s. 0d.
Questions and Answers on Hot Water Supply. (Newnes.) 1946. 5s. 0d.

N. Wignall. *Students Handbook of Heating and Ventilation.* (Heating and Ventilating Engineer.) 1939. 10s. 0d.

LIGHTING

A. D. S. Atkinson. *Fluorescent Lighting.* (Newnes.) 1944. 12s. 6d.

H. Cotton. *Electric Discharge Lamps.* (Chapman and Hall.) 1946. 36s. 0d.

Electric Lamp Manufacturers Association. *Illumination Design Data.* (Privately printed.)

C. J. W. Grieveson (Ed.). *A Symposium on Illumination.* (Chapman and Hall.) 1935. O.P.

G. B. Hughes. *Modern Industrial Lighting.* (Hutchinson.) 1943. 15s. 0d.

C. H. Ridge and F. S. Aldred. *Stage Lighting.* (Pitman.) 1935. 12s. 6d.

J. Swarbrick. *Easements of Light.* (Batsford.) 1938. 10s. 6d.

Lighting Service Bureau Publications :

Floodlighting.
Fluorescent Lamps.
Interior Lighting Design.
Light and Colour.
Lighting in Industry.
Modern Factory Lighting.
The Science of Seeing.
School Lighting by Electricity.
Street Lighting by Electricity.

Post-War Building Studies No. 12.

MASONRY

J. V. Elsden. *The Stones of London.* (Warby.) 1923. O.P.
T. B. Nichols. *An Introduction to Masonry.* (English Universities Press.) 1936. 4s. 0d.
F. J. North. *Limestones.* (Allen and Unwin.) 1938. 17s. 6d.
E. G. Warland. *Modern Practical Masonry.* (Batsford.) 1929. 25s. 0d.
Constructional Masonry. (Pitman.) 1946. 10s. 0d.
A. R. Warnes. *Building Stones, Their Properties, Decay and Preservation.* (Benn.) 1926. 16s. 0d.
Post-War Building Studies No. 18.

PLUMBING AND SANITATION

E. G. Blake. *Plumbing.* (Technical Press.) 1935. 2 vols. 12s. 0d.
E. H. Blake. *Drainage and Sanitation.* (Batsford.) 1942. 15s. 0d.
H. H. Clay. *Sanitary Inspectors Handbook.* (Lewis.) 1942. 18s. 0d.
G. M. Flood. *Sewage Disposal from Isolated Buildings.* (Sutherland.) 1929. O.P.
G. E. Mitchell. *Sanitation Drainage and Water Supply.* (Newnes.) 1946. 12s. 6d.
E. Molloy (Ed.). *Plumbing and Gas-fitting.* (Newnes.) 1946. 15s. 0d.
S. G. B. Stubbs (Ed.). *Encyclopaedia of Plumbing, Heating and Sanitary Engineering.* (Waverley.) 1941. 3 vols. O.P.
S. Swift. *Sanitary Administration.* (Butterworth.) 1944. 35s. 0d.
E. T. Swinson. *Plumbing and Domestic Engineering.* (Newnes.) 1936. 4 vols. 32s. 0d.
H. G. Warren. *Drainage of Buildings.* (Technical Press.) 1938. 3s. 6d.
Post-War Building Studies No. 4.

ROOFING

F. Bennett and A. Pinion. *Roof Slating and Tiling.* (Caxton.) 1935. O.P.
E. G. Blake. *Roof Coverings.* (Chapman and Hall.) 1925. 12s. 0d.
C. G. Dobson. *Roof Tiling.* (Technical Press.) 1931. 14s. 0d.
J. Millar. *Slating and Tiling.* (English Universities Press.) 1937. 5s. 0d.
E. Molloy. *Roof Construction and Repair.* (Newnes.) 1941. 6s. 0d.
Post-War Building Studies, No. 15.

STEEL STRUCTURES

O. Faber. *Examples of Steel Design under the New Code of Practice.* (O.U.P.) 1934. 7s. 6d.
D. H. Lee. *Steelwork in Buildings under the L.C.C. Code of Practice.* (Spon.) 1933. 5s. 0d.
A. R. Moon. *Design of Welded Steel Structures.* (Pitman.) 1939. 18s. 0d.
T. J. Reynolds and L. E. Kent. *Structural Steelwork.* (English Universities Press.) 1936. 12s. 6d.
H. P. Smith. *Structural Steelwork.* (Crosby Lockwood.) 1937. 2s. 6d.
Reports of the Steel Structures Research Committee, 1931–38. (H.M.S.O.) O.P.
Post-War Building Studies, No. 7.

TIMBER, CARPENTRY AND JOINERY

E. H. B. Boulton and B. A. Jay. *British Timbers.* (Black.) 1946. 12s. 6d.
Building Timbers. (Newnes.) 1943. 7s. 6d.
E. H. B. Boulton. *Pocket Book of British Trees.* (Black.) 1944. 7s. 6d.
Timber Buildings for the Country. (Country Life.) 1939. 10s. 6d.
G. Ellis. *Modern Practical Carpentry.* (Batsford.) 1927. 30s. 0d.
Modern Practical Joinery. (Batsford.) 1928. 3 vols. O.P.
R. Greenhalgh. *Joinery and Carpentry.* (Pitman.) 1940. 4 vols. 30s. 0d.
A. L. Howard. *Timbers of the World.* (Macmillan). 1934. 36s. 0d.
A. D. Wood and T. G. Linn. *Plywoods.* (Johnston.) 1942. 25s. 0d.
Timber Development Association "Red Books":
Chemical Seasoning of Timber.
Fireproofing of Timber.
Home Grown Timber Trees.
Prefabricated Timber Houses.
Stress Grading.
Timber Pests—Origin, Prevention and Cure.
Timber—Outline of Structure, Properties and Use.
Timber Preservation.
Timber Seasoning.
Wood Flooring.

TYPES OF BUILDING

Factories

E.L.M.A. *Modern Factory Lighting.* (The Association). 1942.
W. J. Hiscox. *Factory Layout : Planning and Progress.* (Pitman.) 1939.
C. G. Holme. *Industrial Architecture.* (The Studio.) 1935. 30s. 0d.
G. B. Hughes. *Modern Industrial Lighting.* (Hutchinson.) 1943.
Bibliography of periodical References in Post-War Building Studies, No. 16.

Farm Buildings

Association for Planning. *New Design for Farm Buildings.* (*Farmer and Stockbreeder.*) 1946.
T. Gambrill. *Stables and Kennels.* (Eyre and Spottiswoode.) 1935. 50s. 0d.
E. Gunn. *Farm Buildings, New and Adapted.* (Long.) 1935. 5s. 0d.
Post-War Building Studies Nos. 17 and 22.

Flats

A. I. Ashworth. *Flats, Design and Equipment.* (Pitman.) 1936. 25s. 0d.
F. R. S. Yorke and F. Gibberd. *The Modern Flat.* (Architectural Press.) 1937. 30s. 0d.

Hospitals

H. P. Adams. *English Hospital Planning.* (R.I.B.A.) 1929. 4s. 0d.

Houses

Association for Planning. *Housing Digest.* (A. and E. Publishers.) 1946. 15s. 0d.
G. Boumphrey. *Your House and Mine.* (Allen and Unwin.) 1938. 15s. 0d.
A. Bertram. *The House : a Machine for Living In.* (Black.) 1938. 15s. 0d.

Building Centre. *Housing*. Vol. I. (Rolls House.) 1937. 30s. 0d.
E. Carter. *Seaside Houses and Bungalows*. (*Country Life*). 1937. 6s. 0d.
J. Gloag and G.Wornum. *House Out of Factory*. (Allen and Unwin.) 1946. 10s. 6d.
A. Hastings. *Week-End Houses*. (Architectural Press.) 1939. 7s. 6d.
N. Lloyd. *A History of the English House*. (Architectural Press.) 1931. 63s. 0d.
R. McGrath. *Twentieth Century Houses*. (Faber.) 1940. 25s. 0d.
J. Madge (Ed.). *Tomorrow's Houses*. (Pilot Press.) 1946. 15s. 0d.
R. Sheppard. *Prefabrication in Building*. (Architectural Press.) 1946. 15s. 0d.
E. M. Willis (Ed.). *The Hub of the House*. (Lund Humphries.) 1946. 6s. 0d.
F. R. S. Yorke. *The Modern House*. (Architectural Press.) 1934. 21s. 0d.
The Modern House in England. (Architectural Press.) 1937. 15s. 0d.
Post-War Building Studies, Nos. I and 23.

Libraries

E. H. Ashburner. *Modern Public Libraries : Their Planning and Design*. (Grafton.) 1946. 25s. 0d.
W. A. Briscoe. *Library Planning*. (Grafton.) 1927. 10s. 6d.
Library Association. *Small Municipal Libraries*. (The Association.) 3s. 6d.

Schools

British Film Institute. *Pamphlets on Use of Films for Teaching*. (The Institute.) 1940–46
Sir F. Clay. *Modern School Buildings*. (Batsford.) 1929. 25s. 0d.
R.I.B.A. *Report on Post-War School Buildings*. 1945.
Planning Our New Schools. Report of Joint Conference on the 1944 Education Act. 1945.
H. M. Wright and R. G. Medwyn. *The Design of Nursery and Elementary Schools*. (Architectural Press.) 1938. 10s. 0d.
Post-War Building Studies, Nos. 2 and 21.

Shops

A. T. Edwards. *The Architecture of Shops*. (Chapman and Hall.) 1937.
B. and N. Westwood. *Smaller Retail Shops*. (Architectural Press.) 1937.
Bibliography of periodical references in Post-War Building Studies, No. 16.

Theatres and Cinemas

H. Ridge and S. S. Aldred. *Stage Lighting*. (Pitman.) 1939. 7s. 6d.
P. M. Shand. *Modern Theatres and Cinemas*. (Batsford.) 1931. 15s. 0d.
A. Wilson. *Scenic Equipment for the Small Stage*. (Allen and Unwin.) 1939. 2s. 6d.

Town Halls

A. C. Cotton. *Town Halls*. (Architectural Press.) 1936. 6s. 0d.

Village Halls

H. C. Dent. *Countryman's College*. (Longmans.) 1944. 1s. 0d.
H. Morris. *The Village College*. (C.U.P.) 1924. O.P.
National Council for Social Service. *Village Halls and Social Centres in the Countryside*. (The Council.) 1945. 3s. 6d.

War Memorials

Royal Society of Arts. *War Memorials*. (The Society.) 1944.
A. Whittick. *War Memorials*. (*Country Life*.) 1946. 30s. 0d.

TOWN AND COUNTRY PLANNING

General Books

Sir P. Abercrombie. *Town and Country Planning*. (O.U.P.) 1933. 3s. 0d.
T. Adams. *Recent Advances in Town Planning*. (Churchill.) 1932. 25s. 0d.
S. D. Adshead. *A New England : Planning for the Future*. (Muller.) 1942. 7s. 6d.
C. Bauer. *Modern Housing*. (Allen and Unwin.) 1934. 20s. 0d.
Bournville Trust. *When We Build Again*. (Allen and Unwin.) 1941. 8s. 6d.
E. Denby. *Europe Rehoused*. (Allen and Unwin.) 1938. 14s. 0d.
S. R. Dennison. *The Location of Industry and the Depressed Areas*. (O.U.P.) 1939. 10s. 0d.
G. and E. McAllister. *Town and Country Planning*. (Faber.) 1941. 12s. 6d.
(Ed. by). *Homes, Towns and Countryside*. (Batsford.) 1945. 18s. 0d.
L. Mumford. *Culture of Cities*. (Secker and Warburg.) 1939. 25s. 0d.
Technics and Civilisation. (Routledge.) 1934. 18s. 0d.
F. J. Osborn. *Green-belt Cities : The British Contribution*. (Faber.) 1946. 12s. 6d.
Planning and Reconstruction Year Book. (Todd.) Annual. 21s. 0d.
P.E.P. *Report on the Location of Industry*. (P.E.P.) 1939. 10s. 6d.
S. E. Rasmussen. *London : the Unique City*. (Cape.) 1937. 15s. 0d.
T. Sharp. *Town and Countryside*. (O.U.P.) 1937. 6s. 0d.
Town Planning. (Penguin Books.) 1940. 1s. 0d.
Anatomy of the Village. (Penguin Books.) 1946. 3s. 6d.
Staples Digests. *Digest of the* Barlow, Scott, *and* Uthwatt Reports. (Staples.) 1943. 2s. 0d.
Town and Country Planning Association. *Country Towns in the Future England*. (Faber.) 1944. 8s. 6d.
R. Tubbs. *Living in Cities*. (Penguin Books.) 1942. 1s. 0d.
E. Wilkinson. *The Town that was Murdered*. (Gollancz.) 1939. 7s. 6d.

HOUSING AND HOUSING NEEDS

C. Aronovici. *Housing and the Masses*. (Chapman and Hall.) 1939. 21s. 0d.
A. Block. *Estimating Housing Needs*. (Architectural Press.) 1946. 10s. 6d.
R. Durant. *Watling : A Survey*. (King and Staples.) 1939. 10s. 0d.
M. J. Elsas. *Housing Before the War and After*. (King and Staples.) 1945. 5s. 0d.
R. Jevons and J. Madge. *Housing Estates : A Study*. (Arrowsmith.) 1946. 7s. 6d.
B. S. Rowntree. *Poverty and Progress*. (Longmans.) 1941. 15s. 6d.
Sir E. D. Simon. *Rebuilding Britain*. (Gollancz.) 1945. 6s. 0d.

RURAL PLANNING AND AMENITY

V. Cornish. *The Preservation of Our Scenery.* (C.U.P.) 1937. 7s. 6d.

Sir D. Hall. *Reconstruction and the Land.* (Macmillan.) 1941. 12s. 6d.

H. J. Massingham. *Remembrance.* (Batsford.) 1942. 10s. 6d.

C. S. Orwin. *Speed the Plough.* (Penguin Books.) 1942. 1s. 0d.

R. G. Stapledon. *The Hill Lands of England.* (Faber.) 1937. 6s. 0d.
The Land, Now and Tomorrow. (Faber.) 1935. 15s. 0d.
The Land. (Faber.) 1942. 12s. 6d.

J. A. Steers. *The Coast-line of England and Wales.* (C.U.P.) 1946. 42s. 0d.

C. Williams-Ellis. *Britain and the Beast.* (Dent.) 1937. 10s. 6d.
England and the Octopus. (Bles.) 1928. 5s. 0d.
On Trust for the Nation. (Elek.) 1946. 25s. 0d.

GARDENS AND LANDSCAPE

Association for Planning. *Trees for Town and Country.* (Lund Humphries.) 1946. 30s. 0d.

R. B. Dawson. *Practical Lawncraft.* (Crosby Lockwood.) 1946. 15s. 0d.

R. Dutton. *The English Garden.* (Batsford.) 1937. 7s. 6d.

B. Henrey and W. J. Bean. *Trees and Shrubs Throughout the Year.* (Drummond.) 1945. 21s. 0d.

C. Tunnard. *Gardens in the Modern Landscape.* (Architectural Press.) 1938. 15s. 0d.

TOWN PLANNING LAW

J. J. Clarke. *Law of Housing and Planning.* (Pitman.) 1937. 17s. 6d.

J. Charlesworth. *Principles of Town Planning Law.* (Stevens.) 1946. 10s. 6d.

H. A. Hill. *Complete Law of Town and Country Planning and the Restriction of Ribbon Development.* (Butterworth.) 1937. 33s. 0d.

W. I. Jennings. *The Law relating to Town and Country Planning.* (Knight.) 1946. 45s. 0d.

Planning Bill, 1947.—Text. (H.M.S.O.) 2s. 0d.

T. H. Sophian. *Town and Country Planning Legislation, 1933–45.* (Waterlow.) 1945. 25s. 0d.

OFFICIAL PUBLICATIONS

All the following (except certain publications of the Building Research Station) are issued by His Majesty's Stationery Office. They can be ordered through any bookseller, or obtained direct from H.M.S.O., the addresses of whose Sales Offices are given on p. 8.

The prices stated are net ; postage must be added when ordering from H.M.S.O. by post. Publications known to be out of print are marked O.P.

The publications have been listed under the Ministries or Departments responsible for their issue. A series of Sectional Lists of Government Publications is now being issued ; copies of these lists may be obtained from H.M.S.O.

MINISTRY OF WORKS

Post-War Building Studies :

1. *House Construction.* By an Inter-Departmental Committee appointed by the Minister of Health, the Secretary of State for Scotland and the Minister of Works. 2s. 0d.
2. *Standard Construction for Schools.* By a Committee appointed by the President of the Board of Education. 6d.
3. *Plastics.* By a Committee convened by The British Plastics Federation. 1s. 0d.
4. *Plumbing.* By the Plumbing Committee of the Building Research Board of the D.S.I.R. 1s. 0d.
5. *The Painting of Buildings.* By a Committee convened by The Paint Research Association. 1s. 0d.
6. *Gas Installations.* By a Committee convened by The Institution of Gas Engineers. 6d.
7. *Steel Structures.* By a Committee convened by The Institution of Civil Engineers. 6d.
8. *Reinforced Concrete Structures.* By a Committee convened by The Institution of Structural Engineers. 6d.
9. *Mechanical Installations.* By a Committee convened by The Institution of Mechanical Engineers. 2s. 0d.
10. *Solid Fuel Installations.* By a Committee convened by the British Coal Utilisation Research Association. 9d.
11. *Electrical Installations.* By a Committee convened by The Institution of Electrical Engineers. 1s. 6d.
12. *The Lighting of Buildings.* By the Lighting Committee of the Building Research Board of the D.S.I.R. 2s. 6d.
13. *Non-Ferrous Metals.* By a Committee convened by the British Non-Ferrous Metals Research Association. 1s. 0d.
14. *Sound Insulation and Acoustics.* By the Acoustics Committee of the Building Research Board of the D.S.I.R. 1s. 0d.
15. *Walls, Floors and Roofs.* By a Committee convened by the Royal Institute of British Architects. 9d.
16. *Business Buildings.* By a Committee convened by the Royal Institute of British Architects. 1s. 0d.
17. *Farm Buildings.* By a Committee appointed by the Minister of Agriculture and Fisheries. 3s. 0d.
18. *The Architectural Use of Building Materials.* By a Committee convened by the Royal Institute of British Architects. 2s. 6d.
19. *Heating and Ventilation of Dwellings.* By the Heating and Ventilation Committee of the Building Research Board of the D.S.I.R. 2s. 6d.
20. *Fire Grading of Buildings.* By the Fire Grading Committee of the Building Research Board of the D.S.I.R., and of the Fire Offices' Committee. 1s. 6d.
21. *School Buildings for Scotland.* By a Committee appointed by the Secretary of State for Scotland. 1s. 0d.
22. *Farm Buildings for Scotland.* By a Committee appointed by the Secretary of State for Scotland. 1s. 6d.
23. *House Construction. Second Report* (See No. 1 above). 1s. 6d.
24. *School Furniture and Equipment.* By a Sub-Committee of the Standards Committee of the Ministry of Works. 6d.

(No. 1 is usually known as the Burt Committee Report ; No. 19 as the Egerton Report.)

MINISTRY OF WORKS (cont.)

Codes of Practice Committee:
First Report. September, 1943. 3d.
Second Report. 1943. 4d.

Standards Committee:
First Progress Report. 1944. 6d.
Second Report. 1945. 6d.
Further Uses of Standards in Building. 1946. 9d.

Committee on the Brick Industry:
First Report. 1942. 6d.
Second Report. 1942. 6d.
Third Report. 1943. 9d.
Appendix to Third Report: The Firing of Common Bricks. 4d.

Education Committee:
Report on Training for the Building Industry. 1943. 1s. 0d.

Payment by Results:
Memorandum on the Essential Works Order. 1944. 4d.
Supplement to Memorandum. 1944. 2d.
Notes for Guidance on Application. 1944. 1d.

Miscellaneous:
The Standard of War-time Building. 1943. 9d.
Standard Schedule of Prices. 1942. O.P.
Supplement. 1943. O.P.
Timber Economy Memorandum No. 5. 1944. 1s. 3d.
The Placing and Management of Building Contracts. 1944. 1s. 0d.
Programme and Progress: The Preparation of Charts for Civil Engineering and Building Contracts. 1944. 9d.
Report on Methods of Building in the U.S.A. 1944. 4d.
Progress Charts for Housing Construction. 1945. 9d.
Production in Building and Civil Engineering. 1945. 6d.
Supplement No. 1. 1946. 9d.
Statistical Tables relating to the Building and Civil Engineering Industries. 1945. 3d.
Temporary Accommodation: Memorandum for Guidance of Local Authorities. 1944. 6d.
Demonstration Houses at Northolt. 1944. 1s. 0d.
D. D. Harrison, J. M. Albery, and M. W. Whiting. *Survey of Prefabrication.* 1945. 40s. 0d.

MINISTRY OF HEALTH

Housing Manual, 1944. 1944. 2s. 0d.
Housing Manual Technical Appendices. 1944. 1s. 6d.

Reports of the Central Housing Advisory Committee:
Design of Dwellings. (Dudley Report.) 1944. 1s. 0d.
Rural Housing. (Hobhouse Report.) 1945. 1s. 0d.
Private Enterprise Housing. 1944. 1s. 0d.
Conversion of Existing Houses. 1945. 1s. 0d.
Reconditioning in Rural Areas. 1947. 9d.

Scottish Housing Advisory Committee:
Planning our New Homes. 1944. 3s. 0d.
Distribution of New Houses in Scotland. 1944. 1s. 0d.
Modernising Our Homes. 1947. 2s. 6d.

Model Byelaws
Series IV. Buildings. 1939. 1s. 6d.
Series IVd. New Streets.
Series XXI. Water Supply. 1947. 3d.
A National Water Policy. (Cmd. 6515.) 1944. 6d.

MINISTRY OF TOWN AND COUNTRY PLANNING

Town and Country Planning Bill. (Bill 26, 1947.) 2s. 0d.
Explanatory Memorandum on the Planning Bill. (Cmd. 7006.) 4d.
Sir P. Abercrombie. *Greater London Plan.* 1944.
Complete Report. 25s. 0d.
Selection of Maps. 10s. 0d.
The Master Plan. 2s. 6d.
F. Longstreth Thompson. *Merseyside Plan.* 1944. 7s. 6d.
Supplementary Illustrations. 7s. 6d.
The Control of Land Use. (Cmd. 6537.) 1944. 3d.
Report by John Dower. *National Parks in England and Wales.* 1945. 1s. 0d.

New Towns Committee (Reith Committee):
Interim Report. (Cmd. 6759.) 1946. 4d.
Second Interim Report. (Cmd. 6794.) 1946. 6d.
Final Report. (Cmd. 6876.) 1946. 1s. 3d.
New Towns Act, 1946. Text. 9d.
Memorandum on Application, 1946. 9d.
Commission on the Distribution of the Industrial Population (Barlow Commission.) (Cmd. 6153.) 1940. O.P.
Committee on Land Utilisation in Rural Areas. (Scott Committee.) (Cmd. 6378.) 1942. O.P.
Expert Committee on Compensation and Betterment. (Uthwatt Committee.) *Interim Report.* (Cmd. 6291.) 1941. O.P.
Final Report. (Cmd. 6386.) 1942. O.P.
Advisory Committee for London Regional Planning, Report. 1946. 2s. 6d.

MINISTRY OF EDUCATION

Education Act, 1944. 2s. 0d.
Education Act, 1946. 4d.
Educational Reconstruction. (Cmd. 6458.) 1943. 6d.
The Nation's Schools—Their Plan and Purpose. 1945. 6d.
Regulations Prescribing Standards for School Premises. (S.R.O., 1945, No. 345.) March, 1945. 6d.
Memorandum on the Building Regulations. (S.R.O. 345.) 6d.
Circular 10: *Draft Building Regulations.* Nov., 1944. 1d.
Circular 90: *Development Plans.* March, 1946. 1d.
Fire Precautions in Schools. 1945. 1s. 0d.
Community Centres. 1944. 9d.
Memorandum on the Planning, Construction and Equipment of Gymnasia in all Types of Schools. P.T. Series No. 14. 1936. 1s. 0d.
Martin S. Briggs. Pamphlet No. 118: *The Training of the Architect.* 1943. 9d.
Pamphlet 115: *Optical Aids to Education.* 1942. 1s. 6d.

MINISTRY OF FUEL AND POWER

Domestic Fuel Policy. Report of the Fuel and Power Advisory Council. (Simon Report.) (Cmd. 6762.) 1946. 1s. 0d.
Domestic Heating in America. Report of Joint Study Group. 1946. 3s. 0d.
Fuel and the Future Conference. October 1946. Reports of Papers Presented. (Not issued for public sale.)
Fuel Efficiency Bulletins.

MINISTRY OF AGRICULTURE

Farm Buildings in North America. (Agriculture Overseas Report No. 2.) 1945. 9d.
National Farm Survey of England and Wales. A Summary Report. 1946. 2s. 0d.
Bulletin No. 30. *Rats and their Destruction.* 6d.

MINISTRY OF TRANSPORT

Design and Layout of Roads in Built-up Areas. Report of Departmental Committee. 1946. 4s. 0d.
Memorandum on Bridge Design and Construction. 1945. 1s. 0d.

D.S.I.R.

BUILDING RESEARCH STATION

Note.—Unless otherwise stated, all the publications listed below are now *out of print*. Copies will be available in many technical libraries, including, in London, the R.I.B.A. Library and the Patent Office Library.

Annual Reports of the Building Research Board, 1926 to 1939. (1939 was the last year of issue.)

R. Fitzmaurice. *The Principles of Modern Building*. Vol. I. *Walls, Partitions and Chimneys*. 1944. 10s. 6d.

R. Fitzmaurice and W. Allen. *Sound Transmission in Buildings*. Practical Notes for Architects and Builders. 1944. 4s. 0d.

Building Science Abstracts. (Monthly) 1s. 6d. (Annual Subscription) 19s. 0d.

Report of the Reinforced Concrete Structures Committee, with Recommendations for a Code of Practice. 1933.

Report of the Stone Preservation Committee. 1927.

Report on Experimental Cottages at Amesbury. 1921.

Special Reports :

1. Sand-lime and other Concrete Bricks.
2. Experiments on Floors.
3. The Stability of Thin Walls
4. The Transmission of Heat and Gases through, and the Condensation of Moisture on, Wall Materials.
5. Building in Cob and Pise de Terre 1922.
6. Graphical Cost Analysis of Cottage Building.
7. Revised and reprinted as Technical Paper No. 6.
8. Fire Resistant Construction. 1927.
9. Lime and Lime Mortars.
10. Slag, Coke Breeze and Clinker as Aggregates.
11. Heat Transmission. 1929.
12. Investigations into the Durability of Architectural Terra-Cotta and Faience. 1929.
13. Effect of Temperature on the Setting Times of Cements, and on the Strength of Cements, Mortars and Concretes. 1929.
14. The Use of Calcium Chloride or Sodium Chloride as a Protection for Mortar or Concrete against Frost. 1929.
15. The Corrosion of Steel by Breeze and Clinker concretes. 1930.
16. Construction Joints in Concrete. 1930.
17. The Estimation of Free Calcium Oxide and Hydroxide. 1931.
18. The Weathering of Natural Building Stones. 1932.
19. The Ternary Alloys of Lead. Their Use in Buildings. 1933.
20. Economic and Manufacturing Aspects of the Building Brick Industries. 1933.
21. Sand-lime Bricks. 1934.
22. Mechanical Properties of Bricks and Brickwork Masonry. 1934.
23. Calcium Sulphate Plasters.
24. Earth Pressure Tables.
25. The Use of Asphalt Mastic for Roofing. 1937.
26. The Reduction of Noise in Buildings. 1939.

Bulletins :

1. Jointless (Magnesium Oxychloride) Floors.
2. Pozzolanas. 1927.
3. The Effects of Moisture Changes on Building Materials. 1928.
4. The Manufacture of Clay Roofing Tiles in France, Belgium and Holland. 1928.
5. The Properties of Breeze and Clinker Aggregates and Methods of Testing their Soundness. 1928.
6. The Prevention of Corrosion of Lead in Buildings. 1929.
7. Hot Cement.
8. Ultra-Violet Window-Glazing. 1930.
9. Bonding new Concrete to old. 1930.
10. The Prevention of Pattern Staining of Plasters. 1931.
11. The Effect of Building Materials on Paint Films (Revised edition). 1934.
12. The Durability of Slates for Roofing (Revised edition). 1934.
13. Asphalt Mastic Roofing.
14. The Reduction of Noise in Buildings (Reprinted). 1934.
15. Lightweight Concrete Aggregates. 1936.
16. External Rendered Finishes : A Survey of Continental Practice. 1938.

Technical Papers :

1. The Stress Analysis of Bow Girders. 1926.
2. Primary Stresses in Timber Roofs.
3. The Permeability of Portland Cement Concrete. 1931.
4. Determination of Free Lime in Portland Cement.
5. The Consistence of Cement Pastes, Mortars and Concrete
6. Thermal Conductivities of Walls, Concretes and Plasters. 1928.
7. Investigations on Breeze and Clinker Aggregates. 1929.
8. The Corrosion of Lead in Buildings.
9. The Estimation of Free Calcium Hydroxide in Set Cements. A Calorimetric Method. 1930.
10. Studies in Reinforced Concrete. I. Bond Resistance. 1930.
11. Studies in Reinforced Concrete. II. Shrinkage Stresses. 1930.
12. Studies in Reinforced Concrete. III. Creep or Flow of Concrete under Load. 1930.
13. The Equivalent Temperature of a Room and its Measurement. 1932.
14. Influence of Temperature upon the Strength Development of Concrete. 1933.
15. Temperature Rise in Hydrating Concrete. 1933.
16. The Quaternary System CaO-Al_2O_3-SiO_2-Fe_2O_3 in Relation to Cement Technology.
17. Experiments on the Freezing of certain Building Materials.
18. Correlation between Laboratory Tests and Observed Temperatures in Large Dams. 1935.
19. The Carbonation of Unhydrated Portland Cement. 1936.
20. Stresses in Reinforced Concrete Piles during Driving.

Building Research Station (cont.)

Studies in Reinforced Concrete :

21. IV. Further Investigations on the Creep or Flow of Concrete under Load. 1s. 0d.
22. V. Moment Redistribution in Reinforced Concrete.
23. VI. Strength and Deformation of R.C. Columns under Combined Direct Stress and Bending.
24. VII. Strength of Long R.C. columns in Short-period Tests to Destruction.
25. VIII. Strength and Deformation of R.C. Slabs subjected to Concentrated Loading.
26. The Solubility of Cements.
27. Investigations on Pozzolanas. I. Pozzolanas and Lime-Pozzolana Mixes. 1s. 0d.
28. Protractors for the Computation of Daylight Factors. 10s. 0d.

War-Time Building Bulletins :

1. Economical Type Designs in Structural Steelwork for Single Storey Factories.
2. The Application of Reinforced Concrete to Wartime Building.
3. Type Designs for Small Huts.
4. Supplementary Type Designs in Structural Steelwork for Single Storey Factories.
5. Economical Type Designs in Reinforced Concrete for Single Storey Factories.
6. Part I. Arch Construction without Centring.
   Part 2. Further Designs for Hut Type Buildings.
7. House Construction.
8. Part 1a. Walls for Factory Buildings.
   Part 1b. Columns for Factory Buildings.
   Part 2. Tubular Steel Trusses and Purlins for Factory Buildings.
   Part 3. A System of Heating for War-time Factories.
9. Conservation of Cement and of Clay Bricks. 1s. 0d.
10. General Principles of War-time Building.
11. Precautions for Concreting and Bricklaying in Cold Weather. 1s. 0d.
12. Emergency Pipe Repairs (Revised edition). 6d.
13. The Fire Protection of Structural Steelwork. 1s. 0d.
14. Centreless Arch Designs.
15. Standard Designs for Single Storey Factories for War Industries. 1s. 0d.

15a. Supplement to No. 15. Further Notes on Factory Design. 6d.

16. Jointing Mortars for Brickwork. 3d.
17. Resistance of Reinforced Concrete Structures to Air Attack. 6d.
18. Fire Stops for Timber Roofs. 1s. 0d.
19. Economy of Timber in Buildings.
20. Sand-Lime Bricks. 3d.
21. Notes on the Repair of War-Damaged Houses. 1s. 0d.

Leaflets on the Repair of War-Damaged Buildings :

Copies of the following may be obtained free of charge from the Director, Building Research Station, Watford. Envelopes should be marked " R.D.B."

1. Introduction to the Repair Series.
2. Repair of structural steelwork damaged by fire.
3. Restoration of paintwork on wood.
4. Repairs to stucco and rendering.
5. Repairs to asphalt and felt roofs.
6. Repairs to timber roofs and floors.
7. Restoration of paintwork on steel.
8. Removal of oil and smoke stains from walls.
9. Eradication and prevention of dry rot.
10. Repair of internal plasterwork.
11. Redecoration of walls and ceilings.
12. Repairs to brickwork.
13. Repair of reinforced concrete columns damaged by high explosive.
14. Repair of multi-storey steel framed buildings damaged by high explosive.
15. Patching of iron sheet and asbestos cement roofing.
16. Removal of camouflage coatings, blackout paints and anti-scatter treatments.
17. Shoring and other precautions against the collapse of damaged buildings and adjacent property.
18. Reinforced concrete columns damaged by fire.
19. The repair of solid concrete and hollow-tile floors damaged by fire.
20. Not yet published.
21. The repair of stone-work damaged by fire.
22. Assessment and repair of damage done by enemy bombing to foundations and other underground structures.

" Notes from the Information Bureau " of the B.R.S.

The following is a list of the last series of these notes (Series 4) published since January, 1937.

They are *not available from H.M.S.O.* Copies may be obtained from the R.I.B.A. at 6d. each, where still in print.

1. The Design of Timber Floors to Prevent Dry Rot.
2. The Design of Concrete Floors to Reduce the Transmission of Sound.
3. The Cure of Smoky Chimneys.
4. External Rendered Finishes.
5. The Thermal Insulation of Buildings.
6. Natural Stone Masonry, Part I—Its Decay, Preservation and Repair.
7. Natural Stone Masonry, Part II—Its Decay, Preservation and Repair.
8. Mortar for Brickwork.
9. Decorating New Plaster and Cement.
10. Concrete Flooring.
11. Bituminous Roofing Felts.
12. Concrete in Sulphate-Bearing Clays and Ground Waters —Part I.
13. The Moisture Resistant Properties of Some Coatings Applied to Wood.
14. The Technique of Sound Insulation : Rigidly Continuous and Discontinuous Structures.

D.S.I.R. (OTHER DEPTS.)

FOREST PRODUCTS RESEARCH

The following is a selection of publications of the Forest Products Research Laboratory, Princes Risborough. Those listed are *out of print* unless otherwise stated.

Special Reports :

1. *The Air-seasoning and Conditioning of Timber.*
2. *The Principles of Kiln Seasoning of Timber.*
5. *The Growth, Structure and Properties of Wood.*

Bulletins :

1. *Dry Rot in Wood.* 4th Edition. 1944. 1s. 0d.
2. *Lyctus Powder Post Beetles.*
3. *British Hardwoods : Their Structure and Identification.*
7. *Home-grown Timbers : Elm.*
12. *Some Characteristics of Home-grown Timbers.* 2s. 0d.

Records :

4. *Timber Seasoning.* 6d.
5. *The Moisture Content of Timber in New Buildings.* 6d.
9. *Methods of Applying Wood Preservatives. Part I., Non-pressure Methods.* 6d.
17. *Wood Preservatives.* (Reprinting.)
27. *Decay of Timber and its Prevention.* 6d.

Handbooks :

The Principal Rots of English Oak. 2s. 0d.
A Handbook of Home-Grown Timber. (War Emergency Ed.) 1s. 6d.
Principal Decays of Softwoods used in Great Britain. 2s. 6d.
A Handbook of Empire Timbers. (New edition, 1944.) 3s. 0d.
Decay of Timber and its Prevention. (In the press.)

FUEL RESEARCH

Special Report No. 3. *The Coal Fire : An Investigation into the Efficiency of Open Fires.* 1920.
Technical Paper No. 46. *The Use of Coke in Open Domestic Grates.* 1937. 1s. 3d.

GEOLOGICAL SURVEY

British Regional Geology. A series of 18 illustrated introductions to district geology of Britain. 1s. 6d.

ILLUMINATION RESEARCH

Technical Papers :

11. *The Efficiency of Light Wells.* 1930. 9d.
12. *Daylight Illumination required in Offices.* 1931. 3d.
17. *Seasonal Variation of Daylight Illumination.* 1935. 4d.
18. *Transmission of Light through Window Glasses.* 1936. 9d.
19. *Daylight Illumination required for Clerical Work.* 1937. 6d.

ROAD RESEARCH

Technical Paper No. 5. *The Grading of Aggregates and Workability of Concrete.* 1938. 1s. 3d.
Soils, Concretes and Bituminous Materials. (In the press.)
Sources of Naturally Coloured Chippings in Great Britain. O.P.

ATMOSPHERIC POLLUTION

Technical Paper No. 1. *Atmospheric Pollution in Leicester : A Scientific Survey.* 3s. 0d.

STEEL STRUCTURES RESEARCH COMMITTEE

First Report. 1931. 5s. 0d.
Second Report. 1934. 7s. 6d.
Final Report. 1936. 12s. 6d.
Recommendations for Design. 1936. 6d.
The Welding of Steel Structures. 1938. 6s. 0d.

BRITISH STANDARD SPECIFICATIONS FOR BUILDING

The following list of British Standards applicable to building work has been corrected as far as possible up to the end of 1946. To facilitate reference the full titles of some Standards have been abbreviated, and the Standards have been grouped under the following headings :—

1. General.
2. Plant and Equipment.
3. Aggregates for Concrete, etc.
4. Brickwork and Masonry.
5. Cement, Lime, and Plaster.
6. Doors and Windows (including glazing).
7. Electrical Appliances and Fittings.
8. Flooring Components.
9. Flues and Flue Pipes.
10. Gas Appliances and Fittings.
11. Ironmongery.
12. Joinery.
13. Painting and Decorating.
14. Rainwater, Soil, and Waste Pipes and Fittings.
15. Road and Paving Materials.
16. Roofing.
17. Sanitary Appliances and Fittings.
18. Solid Fuel Appliances and Boilers.
19. Steel.
20. Timber.
21. Underground Drainage and Supply Pipes.
22. Water and Gas Service Pipes and Fittings.
23. Water Supply Fittings.

The year following the number of the Standard indicates the latest edition, and should always be quoted. *Add.* after the title signifies that a subsequent amendment was issued in the year stated. * Before the number signifies a " War Emergency " Standard.

PRICES

All Standards are priced at 2s. 0d. net unless otherwise stated, and are obtainable from the British Standards Institution, 28, Victoria Street, London, S.W.1. (Tel. Abbey 3333). Standards should be ordered by number rather than title and the cost of postage added.

GENERAL PUBLICATIONS

The following are issued by the B.S.I. giving abstracts from, and lists of, Standards :—

Handbook No. 3.—" British Standards for Building Materials and Components." 12s. 6d. Gives the essential features of 164 Standards.

Supplement to Handbook No. 3.—Treats a further 82 building Standards.

British Standards Year Book. 2s. 0d.—Contains a subject index and a short summary of every Standard issued in numerical order, with lists of withdrawn Standards and other information.

Sectional Industry Lists are issued free for various industries, including building.

Monthly Information Sheets keep the numerical list of Standards in the Year Book up-to-date.

REFERENCE SETS

A list of libraries at which complete sets of Standards are maintained is given at the end of this section.

STANDARDS NOT AVAILABLE

‡ signifies temporarily out of print.
Standards under revision are marked †.

1. GENERAL

Calculations

Conversion factors and tables. (3s. 6d.)	**350 : 1944**
Engineering symbols and abbreviations. *Add.* 1945. (3s. 6d.)	**560 : 1934**
Unit weights of building materials.	**648 : 1935**

Definitions

Acoustical terms, glossary.	**661 : 1936**
Electrical terms, lighting and heating.	**205 : Pt. 6 : 1943**
Fire resistance of building materials and structures, definitions. *Add.* 1942 and 1945.	**476 : 1932**
Heat insulating terms, definitions.	**874 : 1939**

Drawing Office

Architectural and building drawing office practice. (5s. 0d.)	**1192 : 1944**
Drawing boards and tee-squares.	**1265/8 : 1945**
Boxwood Scales	**1347 : 1947**
Drawing papers, tracing detail and cartridge.	**1340/3 : 1946**
Electrical graphical symbols. (1s. 0d.)	**447 : 1932**

Services

Identification of pipes, cables and conduits in buildings.	**617 : 1942**
Code of practice for engineering and utility services in buildings.	**1043 : 1942**

Specification

Sequence of trade headings and specification items for building work.	**‡685 : 1937**

Trade Literature

Sizes and contents arrangement for trade and technical literature, building industry. (1s. 0d.)	**1311 : 1946**

Wages

Time and wage sheets and pay packets for the building industry. *Add.* 1946.	**1151 : 1945**
Guaranteed minimum wage reckoners. (1s. 0d.)	**1151 : Pt. 2 : 1945**

2. PLANT AND EQUIPMENT

Cranes

Power-driven derrick. *Add.* 1934 and 1942.	**327 : Pt. 1 : 1934**
Hand-operated derrick. *Add.* 1942.	**327 : Pt. 2 : 1933**
Travelling jib cranes (contractors'). *Add.* 1941.	**357 : 1930**

Slings and Ropes

Wire ropes for cranes, lifts and excavators.	**621 : 1935**
Wire ropes for lifts and hoists.	**329 : 1939**
Crane chain, short link.	**394 : 1944**
Chain slings and rings. *Add.* 1938. (3s. 6d.)	**781 : 1938**
Shackles for lifting.	**825 : 1939**
Manilla ropes for general purposes.	**431 : 1946**
Sisal ropes for general purposes.	**908 : 1946**

Ladders

Timber ladders.	***1129 : 1943**

Scaffolding

Tubular steel scaffolding.	***1139 : 1943**

Concrete mixers

Batch type.	**1305 : 1946**

Tools

Hand hammers. *Add.* Apr. 1940.	**876 : 1939**
Picks and mattocks.	**In preparation**

3. AGGREGATES FOR CONCRETE, Etc.

Natural (Issued in one volume 5s. 0d.)

Coarse and fine aggregates for concrete.	**882 : 1944**
Natural and crushed stone sands :	
for plastering.	**1198 : 1944**
for external renderings.	**1199 : 1944**
for brickwork and masonry.	**1200 : 1944**
for granolithic concrete floors.	**1201 : 1944**

Slag

Foamed blast furnace slag for concrete.	**877 : 1939**
Air-cooled blast furnace slag coarse aggregates.	***1047 : 1942**

Clinker

Clinker aggregate for plain concrete.	**1165 : 1944**

Brick

Crushed brick aggregate.	**In preparation**

Testing

Methods for sampling and testing mineral aggregates, sands, and fillers. *Add.* 1946. (3s. 6d.)	**†812 : 1943**

4. BRICKWORK AND MASONRY

Bricks

Dimensions of common building bricks. (1s. 0d.)	**†657 : 1941**
Clay engineering bricks.	**1301 : 1946**
Sand lime (calcium silicate) bricks.	**187 : 1942**
Concrete bricks and fixing bricks.	**1180 : 1944**
Methods of testing clay building bricks.	**1257 : 1945**
General building bricks.	**In preparation**
Cellular and perforated bricks.	**In preparation**

Construction

Load bearing of concrete, brickwork and masonry (unreinforced).	**1145 : 1943**
Reinforced brickwork.	**1146 : 1943**

Cast Stone and Concrete

Cast stone.	**1217 : 1945**
Precast concrete blocks (Issued in one volume) :	
Solid partition blocks.	**492 : 1944**
Hollow partition blocks.	**728 : 1944**
Blocks for rendered walls.	**834 : 1944**
Cast concrete :	
Copings.	**1234 : 1945**
Sills.	**1237 : 1945**
Lintels.	**1239 : 1945**

Natural Stone

Natural stone for building.	**1232 : 1945**
Natural stone copings.	**1235 : 1945**
sills.	**1238 : 1945**
lintels.	**1240 : 1945**
Classification of building stones.	**In preparation**

4. BRICKWORK & MASONRY (contd.)

Walling blocks and slabs

Hollow clay building blocks.	**1190 : 1944**
Hollow glass blocks.	**1207 : 1944**
Wood wool building slab. (1s. 0d.)	**1105 : 1943**
Glazed earthenware wall tiles.	**1281 : 1945**
Aerated concrete blocks.	**In preparation**
Gypsum plaster blocks.	**In preparation**

Damp Courses

Materials for horizontal damp-proof courses, including classification.	**†743 : 1941**
Coal tar pitch felt damp courses. (1s. 0d.)	***1067 : 1942**
Mastic asphalt for d.p.c. and tanking.	**1097 : 1943**
Coal tar pitches for building purposes.	**1310 : 1946**
Waterproof papers for underlays.	**In preparation**

Miscellaneous

Airbricks and gratings.	**493 : 1945**
Metal wall ties.	**1243 : 1945**
Metal fixings for masonry.	**In preparation**

5. CEMENT, LIME AND PLASTERS
(Including wall and building boards.)

Cement

Ordinary and rapid-hardening Portland.	**†12 : 1940**
Blastfurnace Portland.	**†146 : 1941**
High alumina cement.	**†915 : 1940**
Pigments for colouring cement and concrete.	**1014 : 1942**

Lime

Building Limes. (3s. 6d.)	**890 :** 1940

Plaster

Gypsum and anhydrite building plasters. *Add.* Sept. 1945.	**1191 : 1944**

Lathing

Wood laths for plastering.	**1317 : 1946**
Expanded metal lathing.	**405 : 1945**

Wall and Building Boards

Plaster board.	**1230 : 1945**
Fibre building board. *Add.* 1945.	**1142 : 1943**
Asbestos cement sheets.	**690 : 1945**
Synthetic-resin and bonded-paper sheet (for wall board or veneers).	**1323 : 1946**

6. DOORS AND WINDOWS
(Including glazing.)

Wood Doors

Panelled and glazed wood doors. Add. 1945.	**459 : Pt. 1 : 1944**
Flush doors.	**459 : Pt. 2 : 1945**
Flush doors with hardboard face.	**In preparation**
Firecheck flush doors.	**459 : Pt. 3 : 1946**
Casement doors.	**644 : Pt. 1 : 1945**
Wooden gates.	**583 : 1944**

Metal Doors

Casement doors. (3s. 6d.)	**990 : 1945**
Metal door frames.	**1245 : 1945**
Internal doors.	**In preparation**

Wood Windows

Wood windows and casement doors. *Add.* 1945	**644 : Pt. 1 : 1945**
Sash windows, double hung, with cased and solid frames.	**644 : Pt. 2 : 1946**

Metal Windows

Metal casement windows. *Add.* 1945. (3s. 6d.)	**990 : 1945**
Wood surrounds for metal windows.	**1285 : 1945**
Metal window sub-frames.	**In preparation**
Windows for schools, offices, and industrial buildings.	**In preparation**
Windows for inward opening and interior glazing	**In preparation**

Glazing

Glass for glazing, including definitions and terminology.	**952 : 1941**
Code of practice for glazing and fixing glass in buildings.	**973 : 1945**
Linseed oil putty, types 1 and 2. *Add.* 1939 and 1940.	**†544 : 1934**

Sills and lintels (Issued in one volume 3s. 6d.)

Clayware sills.	**1236 : 1945**
Cast concrete sills.	**1237 : 1945**
Natural stone sills.	**1238 : 1945**
Cast concrete lintels.	**1239 : 1945**
Natural stone lintels.	**1240 : 1945**
Glass internal sills for wood and metal windows.	**1209 : 1945**

7. ELECTRICAL APPLIANCES AND FITTINGS

Cables

Rubber and PVC insulated cables and flex. (3s. 6d.)	**7 : 1946**
Metal sheathed paper insulated cables. *Add.* 1943 and 1945.	**†480 : 1942**
250-volt paper-insulated cables for internal wiring. (1s. 0d.)	***1068 : 1942**

Conduits and Ducts

Steel conduits and fittings. *Add.* Mar. 1942.	**31 : 1940**
Grey cast iron conduit boxes.	**820 : 1938**
Underfloor steel ducts and fittings.	**774 : 1938**
Underfloor non-metallic ducts and fittings.	**815 : 1938**
Light-gauge copper conduit and fittings.	**840 : 1939**
Earthing clamps for pipes up to 3 in.	**†951 : 1941**

Domestic Appliances

Minimum requirements for appliances and fittings (not covered by other B.S.).	**816 : 1938**
Space required for domestic appliances. *Add.* June, 1946.	**1183 : 1944**
Fans, ceiling type.	**367 : 1941**
Fans, desk type.	**380 : 1930**
Cooker control units.	**†438 : 1941**
Clocks, synchronous	**472 : 1932**
Refrigerators, domestic.	**922 : 1940**
Ovens, domestic, cooking tests.	**1315 : Pt. 1 1946**
Wash-boilers, free-standing domestic.	**1326 : 1946**
Elements for electric fires.	**In preparation**

Distribution Boards

Up to 100 amp. and 250 volt.	**†214 : 1939**

7. ELECTRICAL APPLIANCES & FITTINGS (contd.)

Fuses

Fuses, up to 800 amp. 250 volt.	88 : 1947
Cartridge fuses for domestic circuits	1361 : 1947
Low voltage cartridge fuse links for plugs	1362 : 1947

Lamps and Lampholders

Bayonet lamp caps, lampholders and plugs.	†52 : 1941
Screw lamp caps and holders.	†98 : 1934
Carbon filament lamps.	‡33 : 1930
Tungsten filament lamps, general service. *Add.* 1942, 1943, and 1946.	161 : 1940
Fittings for double-capped tubular lamps. *Add.* 1935 and 1942.	495 : 1933
Architectural lamps, caps and holders. *Add.* 1942.	841 : 1939
Discharge lamps, general purpose.	1270 : 1946

Lighting Fittings

Ceiling roses, 2 and 3 terminal.	67 : 1938
Watertight fittings (outdoor).	97 : 1926
Reflectors, enamelled steel, open dispersive type.	232 : 1938
Study and reading table lamp.	710 : 1936
Daylight fittings for colour matching.	950 : 1941
Reading lamps.	In preparation
Well glass fittings.	In preparation

Meters

Electricity meters. *Add.* 1938 and 1946.	†37 : 1937
Meter cupboards.	In preparation
Prepayment meters.	In preparation

Plugs and Sockets

Two-pole, and earthing-pin types. *Add.* 1934, 1935, 1938 and 1942.	546 : 1934
Reversible connectors for portable appliances.	562 : 1934
Connectors for bell and telephone circuits.	732 : 1937
Domestic outlet and plug, new type.	1363 : 1947

Signs

Signs and luminous discharge tube installations. *Add.* 1938, 1941.	559 : 1938

Switches

Air-break switches, up to 660 volt. *Add.* 1946.	861 : 1939
Tumbler switches, switch plates and boxes (5 amp. flush type).	1299 : Pt. 1 : 1946

Water Heaters

Thermal storage heaters, thermostatically controlled, 1½ to 100 gallon.	†‡843 : 1939
Immersion heaters, domestic.	In preparation
Thermostats for hot water supply.	In preparation

8. FLOORING COMPONENTS

Asphalt and Mastic

Mastic asphalt for flooring.	1076 : 1942
Pitch mastic flooring. *Add.* 1944.	*1093 : 1944
Ditto, incorporating lake asphalt.	*1177 : 1944
Coloured pitch and asphalt mastic floorings.	In preparation

Linoleum and Cork

Plain linoleum and cork carpet.	‡810 : 1938
Cork slab flooring.	In preparation

Oxychloride

Materials for magnesium oxychloride flooring compositions.	776 : 1938

Rubber

Rubber flooring.	In preparation

Tiles

Clay flooring tiles. *Add.* 1946.	1286 : 1945
Concrete flooring tiles.	1197 : 1944
Asphalt flooring tiles :	
Natural rock asphalt.	1324 : 1946
Mineral aggregate with no inherent bitumen.	1325 : 1946

Timber

See under Joinery.

Wood Block

Wood blocks for floors.	1187 : 1944
Bitumen adhesives for floors.	In preparation

9. FLUES AND FLUE-PIPES

Pipes

Cast iron spigot and socket flue pipes.	41 : 1946
Asbestos cement flue pipes and fittings (heavy quality).	835 : 1945

Gas Appliance Flues

Asbestos cement flue pipes and fittings. *Add.* 1945.	567 : 1945
Sheet metal flue pipes and fittings.	715 : 1936
Precast concrete flue blocks for gas fires.	1289 : 1945
Bafflers and draught-diverters for gas flues.	766 : 1938

Solid Fuel Flues

Clay flue linings and chimney pots.	1181 : 1944
Soot doors for domestic buildings.	1294 : 1946

10. GAS APPLIANCES AND FITTINGS

Domestic Appliances

General specification, space and rating requirements for. *Add* 1946.	1250 : Pt. 1 : 1945
Detailed requirements for cookers, water heaters, fires, space heaters, refrigerators.	1250 : Pt. 2 : 1946

Fittings

Plug and socket connectors for gas appliances.	570 : 1934
Flexible tubing and connectors for portable appliances.	669 : 1936
Meter unions.	746 : 1937
Low pressure gas mantles.	884 : 1941
Meter cupboards.	In preparation
Lighting units.	In preparation
Gas main cocks.	In preparation

Pipes

See under " Water Supply."

11. IRONMONGERY

Hardware

Builders' hardware for housing (furniture for doors, windows, cupboards, etc.).	1331 : 1946
Door bolts, iron, steel and non-ferrous.	1228 : 1945
Hinges.	1227 : 1945
Locks and latches for doors (sizes).	455 : 1945
Sash lines, plaited.	†606 : 1935
Black bolts and nuts, hexagon and square.	916 : 1946
Floor springs for doors.	In preparation
Axle pulleys for sash windows.	In preparation

Nails and Screws

Wire and cut nails.	1202 : 1944
Steel and brass wood screws.	1210 : 1945

12. JOINERY

(See also under " Timber,")

General

Grading of softwood joinery.	1186 : 1944
Wood trim (skirtings, picture rails, beads, cover strips, etc.).	584 : 1945
Staircases with close strings.	585 : 1944
Kitchen fitments and equipment *Add.* 1945.	1195 : 1944
Storage fitments for living-rooms and bed-rooms.	1292 : 1945
Constructional requirements for kitchen fitments.	In preparation
Timber connectors.	In preparation

Flooring

Grading and sizing of softwood T. and G. flooring.	1297 : 1946

Adhesives

Joiners' glue.	945 : 1937
Issued in one volume :	
Synthetic resin adhesives for plywood.	1203 : 1945
Cold-setting synthetic resin adhesives.	1204 : 1945

13. PAINTING AND DECORATING

Paints

Ready-mixed paints (oil gloss). *Add.* 1939 and 1941. (3s. 6d.)	261 : 1936
Ready-mixed paints, priming, undercoating, and finishing (oil gloss). *Add.* 1943.	†*929 : 1943
Red lead ready-mixed paints. *Add.* 1942.	1011 : 1942
Priming paint (lead base) for protection of steel sheet. *Add.* 1942.	*1033 : 1942
Black (tar base) paint for use on iron and steel.	*1070 : 1942
Fire retardant paints.	In preparation
Flat oil paints.	In preparation
Knotting.	In preparation
Hard gloss paints.	In preparation

Distemper

Water paints and distemper for interior use.	*1053 : 1942

Varnishes and Stains

Varnishes (oil and hard drying). (3s. 6d.)	256 : 1936
Oil stains.	1215 : 1945

Colours

B.S. schedule for ready-mixed paints.	‡381 : 1930
B.S. Colours for ready-mixed paints. (1s. 0d.)	381C : 1944
B.S. flat colours for wall decoration. (6d.) (Set of 10 specimen colours to B.S. 381WD : 1945. 4s. 0d.)	381WD : 1945

Practice

Painting of buildings in wartime.	*1056 : 1942

Wall Paper

Wall papers *Add.* 1946.	1248 : 1945

14. RAINWATER, SOIL AND WASTE PIPES AND FITTINGS

Rainwater Goods

Cast iron pipes, fittings and accessories.	460 : 1944
Cast iron gutters and accessories :	
Half round gutters.	1205 : Pt. 1 : 1945
O.G. gutters.	1205 : Pt. 2 : 1945
Pressed steel pipes, gutters and fittings.	1091 : 1946
Asbestos cement pipes, gutters and accessories.	569 : 1945

Soil and Waste Pipes

Cast iron spigot and socket pipes, fittings and accessories. (3s. 6d.)	416 : 1944
Asbestos cement spigot and socket pipes and fittings.	582 : 1945

15. ROAD AND PAVING MATERIALS

Asphalt

Mastic asphalt for roads and footways.	596 : 1945
Asphalt macadam. *Add.* 1930.	347 : 1928
Mastic asphalt surfacing (hot process).	597 : 1935

Kerbs and Setts

Precast concrete kerbs channels and quadrants. *Add.* 1938.	†340 : 1936
Granite and whinstone kerbs, channels, quadrants and setts.	435 : 1931
Sandstone ditto.	706 : 1936

Lighting

Street Lighting.	‡307 : 1931
Lamp-posts :	
Cast iron.	1249 : 1946
Reinforced concrete.	1308 : 1946

Paving Slabs

Precast concrete flags.	368 : 1936

Stone

Sizes of road stone and chippings	63 : 1939

Tarmacadam

Granite, limestone or slag aggregate.	802 : 1945
Gravel aggregate.	1241 : 1945
" Tarpaving " for footpaths and playgrounds.	1242 : 1945

16. ROOFING

Asphalt

Mastic asphalt for roofing :	
Natural rock with high bitumen content.	1162 : 1944
Limestone aggregate, type A,	988 : 1941

Metal Roofing

Copper sheet and strip, cold rolled.	899 : 1940
Milled lead sheet and strip. (1s. 0d.)	1178 : 1944
Plain sheet zinc roofing, code of practice. *Add.* 1939.	†849 : 1939

Roofing Felts

Bituminous roofing felts.	†747 : 1937
Bitumen and fluxed pitch roofing felts.	*989 : 1944

Roofing Sheets

Galvanised corrugated steel sheets.	†798 : 1938
Asbestos cement flat and corrugated sheets.	690 : 1945

Slates

Natural roofing slates.	680 : 1944
Asbestos cement slates.	690 : 1945

Tiles

Clay plain tiles and fittings.	402 : 1945
Concrete plain tiles and fittings.	473 : 1944
Concrete interlocking tiles.	550 : 1945
Single lap clay tiles.	In preparation

Timber Battens

Wood battens for slating and tiling. (1s. 0d.)	1318 : 1946

17. SANITARY APPLIANCES AND FITTINGS

Baths

Cast iron baths.	1189 : 1944
Panels for baths.	1189 : Pt. 2 : 1945

Lavatory Basins

Ceramic lavatory basins.	1188 : 1944
Brackets and supports.	1255 : 1945
Metal lavatory basins	1329 : 1946

Sinks

Fireclay sinks.	1206 : 1945
Fireclay wash-tubs and sink sets.	1229 : 1945
Metal sinks.	1244 : 1945
Brackets and supports.	1255 : 1945
Draining boards.	1226 : 1945

W.C. Suites

Under revision with a view to combination :	
Ceramic washdown W.C. pans.	1213 : 1945
Syphonic W.C. pans.	In preparation
W.C. flushing cisterns.	1125 : 1945
Plastic W.C. seats.	1254 : 1945
Flushing valves.	In preparation

Traps

Drawn lead traps.	504 : 1944
Non-ferrous traps and wastes.	1184 : 1944
Ferrous traps for baths.	1291 : 1946

Unclassified

Taps, bib, pillar, globe and stop. *Add.* 1945 and 1946	1010 : 1944
Non-ferrous thimbles and ferrules.	1182 : 1944
Stop-tap guard pipes.	1185 : 1944
Nickel and chromium plating of steel and brass.	1224 : 1945
Dustbins, mild steel	792 : 1938
Ball valves.	In preparation
Mixing valves for showers.	In preparation

18. SOLID FUEL APPLIANCES AND BOILERS

Boilers

Small domestic hot water supply boilers. (3s. 6d.)	758 : 1945
Boilers for central heating and hot water supply :	
Cast iron sectional. *Add.* 1939.	†779 : 1938
Rivetted steel. *Add.* 1939.	†780 : 1938
Welded steel (steam central heating).	†854 : 1939
Welded steel (hot water).	†855 : 1939

Cookers and Combination Grates

Solid fuel cookers and combination grates.	1252 : 1945
Cooking ranges.	In preparation
Cooking tests.	In preparation

Grates and Stoves

Open fires for domestic purposes.	1251 : 1945
Solid fuel heating stoves.	In preparation

19. STEEL

Dimensions of Structural Sections

Channels and I-beams.	4 : 1932
Angles and tee-bars.	4a: 1934
Bulb angles and bulb plates. (1s. 0d.)	6 : 1924

Qualities

Steel for bridges and general building construction. *Add.* 1938 and 1941.	15 : 1936
High tensile steel. *Add.* 1936 and 1942.	548 : 1934
High tensile, fusion welding quality. *Add.* 1943.	968 : 1941

Construction

Use of structural steel in building. *Add.* 1940.	449 : 1937

Welding

Metal arc welding in mild steel for general building construction.	†538 : 1940
Oxy-acetylene welding for mild steel.	693 : 1940
Metal arc welding of tubular structural members.	938 : 1941
Methods of testing welded joints.	709 : 1940

Reinforcement for Concrete

Rolled Steel bars and hard-drawn wire for concrete reinforcement. *Add.* 1942.	785 : 1938
Cold twisted steel bars.	1144 : 1943
Steel fabric for reinforcement.	1221 : 1945
Bar bending dimensions.	In preparation

20. TIMBER

Construction

Timber in building construction—floors.	**1018 : Pt. 1 : 1942**

Grading and Stresses

Grading rules :	
For stress-graded timber.	**940 : Pt. 1 : 1944**
For structural timber where stresses are known.	**940 : Pt. 2 : 1942**
Sizes of stress graded softwood.	**1175 : 1944**
Grading of softwood joinery.	**1186 : 1944**

Nomenclature

For commercial timbers, including botanical names and sources of supply : Issued in one volume. (7s. 6d.)	
Hardwoods.	**881 : 1946**
Softwoods.	**589 : 1946**
Terms and definitions applicable to softwoods and hardwoods.	**†565 : 1938**

Testing

Methods of testing small timber specimens.	**373 : 1938**
Methods of testing for moisture.	**In preparation**

Preservation

Classification of wood preservatives.	**1282 : 1945**
Creosote for timber preservation. *Add.* 1941.	**144 : 1936**
Pressure creosoting of timber.	**913 : 1940**

Plywood

Grading of plywood (veneered).	**†585 : 1935**
General specification.	**In preparation**

21. UNDERGROUND DRAINAGE AND SUPPLY PIPES

(Drainage, Gas and Water.)

Glazed ware Drain Pipes

Salt-glazed pipes, tapers, bends and junctions.	**†65 : 1937**
Glazed fireclay pipes, tapers, bends and junctions.	**†540 : 1937**
Glazed ware drain fittings.	**539 : 1937**
Special glazed ware pipes (chemically resistant grade).	**1143 : 1943**

Concrete Pipes

Concrete cylindrical pipes and tubes (not reinforced).	**556 : 1945**

Land Drain Pipes

Concrete porous pipes for underdrainage.	**1194 : 1944**
Clayware field drain pipes.	**1196 : 1944**

Asbestos Cement Pipes

Asbestos cement pressure pipes.	**†486 : 1933**

Cast Iron Pipes

For water, gas, and sewage :	
Vertically cast. (5s. 0d.)	**78 : 1938**
Centrifugally cast (spun).	**1211 : 1945**
Cast on the incline.	**In preparation**
Spigot and socket drain pipes. *Add.* 1943	**†437 : 1933**
Schedule of spigot and socket drain fittings.	**†1130 : 1943**
Flanged, for hydraulic mains.	**44 : 1909**

Steel Pipes

Steel spigot and socket pipes and specials for water, gas and sewage. *Add.* 1943.	**†534 : 1934**
Steel tubes for water well casing.	**879 : 1939**

Pipe Jointing

Rubber joint rings for water mains and sewers.	**674 : 1942**
Rubber and insertion jointing for flanged pipes. *Add.* 1945.	**945 : 1943**
Jointing paste for flange and similar joints.	**1260 : 1945**

Manhole Fittings

Cast manhole covers, road gulley gratings and frames.	**497 : 1945**
Manhole step irons.	**1247 : 1945**

Valves

Sluice valves for waterworks purposes.	**1218 : 1945**

22. WATER AND GAS SERVICE PIPES AND FITTINGS

Copper Pipes

Tubes, heavy gauge, for screw threads.	**61 : Pt. 2 : 1946**
Fittings for use with tubes to B.S.61 *Add.* 1927.	**†99 : 1922**
Tubes, light gauge, ¼″–4″ dia. *Add.* 1946.	**659 : 1944**
Capillary and compression fittings for use with light gauge tube.	**†864 : 1945**

Iron and Steel Pipes

In gas, water, and steam qualities :	
Wrought iron tubes and tubulars. *Add.* 1938 and 1939.	**†788 : 1938**
Steel tubes and tubulars. *Add.* 1938 and 1939.	**†789 : 1938**
Steel tubes (revised weights).	***789A : 1940**
Screwed pipe fittings, malleable C.I. and cast copper alloy, B.S.P. threads. (3s. 6d.)	**1256 : 1945**
Jointing compound for screwed joints.	**1261 : 1945**

Lead Pipes

For other than chemical purposes.	**†602 : 1939**
B.N.F. ternary alloy pipes.	**603 : 1941**
Silver-copper-lead alloy pipes.	**1085 : 1946**

23. WATER SUPPLY FITTINGS

(See also " 18. Solid Fuel Appliances.")

Boilers

See " Solid Fuel Appliances."

Lagging

" Ready to fit " thermal insulating materials for hot and cold water supply.	**1304 : 1946**

Pipes

See " Water and Gas Service Pipes."

Pumps

Semi-rotary pumps, hand operated.	**1208 : 1945**

Taps

See " Sanitary Fittings."

Tanks and Cylinders

Galvanized mild steel cisterns, tanks and cylinders.	**417 : 1944**
Copper cylinders (3 grades). *Add.* 1945.	**699 : 1944**
Calorifiers. (3s. 6d.)	**†853 : 1939**
Asbestos cement cisterns.	**In preparation**
Indirect cylinders.	**In preparation**

REFERENCE SETS OF BRITISH STANDARDS

Complete sets of British Standards are maintained, for reference purposes, by the following Public Libraries and Colleges in the British Isles :

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Blackburn	Public Library, Museum and Art Gallery.
Bolton	Central Library.
Bradford	Central Public Library.
Bristol	Central Library.
Cambridge	Engineering Laboratory, Cambridge University and the University Library.
Cardiff	Central Library.
Chelmsford	Public Library and Museum.
Croydon	Central Library.
Darlington	Public Library and Museum.
Dublin	Trinity College.
Dundee	Public Library, Museum and Art Gallery.
Edinburgh	Public Library ; Edinburgh University ; and the National Library of Scotland.
Glasgow	Glasgow University and the Mitchell Library.
Hull	Central Public Library.
Leeds	University of Leeds and the Central Public Library.
Leicester	Municipal Library.
Lincoln	Public Library.
Liverpool	Public Library.
London	Library of the British Standards Institute; Patent Office Library ; City and Guilds Engineering College ; King's College ; Science Library, Science Museum ; University College and the British Museum ; Battersea Public Library ; Deptford Public Library ; Hammersmith Public Library ; Ilford Public Library ; Islington Central Library ; West Ham Public Library ; Westminster Public Library.
Luton	Central Library.
Manchester	College of Technology ; Victoria University ; and the Central Library.
Middlesbrough	Public Library.
Newcastle-on-Tyne	King's College and the Public Library.
Nottingham	Engineering Department, University College and the Public Library.
Oldham	Central Library.
Oxford	Bodleian Library and the Engineering Laboratory, Oxford University.
Portsmouth	Central Library.
Preston	Harris Public Library.
Rochdale	Public Library.
Sheffield	Central Library.
Southampton	Public Library.
Swansea	Central Public Library.
Wolverhampton	Central Public Library.

OFFICIAL CODES OF PRACTICE

The Codes of Practice Committee was established in September, 1942, as the result of negotiations initiated by the Minister of Works, in consultation with the Ministry of Health and other Government Departments.

It consists of nominees of the principal Professional and Scientific Institutions, the British Standards Institution and the Building Industries National Council, with assessor members nominated by certain Government Departments, and a Chairman appointed by the Minister of Works.

Its terms of reference are "To direct the preparation of Codes of Practice for civil engineering, public works, building and constructional work."

A comprehensive scheme of standard Codes of Practice has been drawn up, and drafting work is undertaken by a series of committees convened by the appropriate professional institutions. Draft Codes are circulated for comment to all interested parties before final publication, which is being undertaken by the British Standards Institution.

The main divisions of the General Series of Building Codes are :

1. Carcase series

- 1.1 Foundations and substructure.
- 1.2 Load-bearing superstructure.
- 1.3 External walling (weather resisting) and party walls.
- 1.4 Weather resisting roof coverings.
- 1.5 Internal walls and partitions.
- 1.6 Doors and windows.
- 1.7 Flues and chimneys.

2. Finishing series

- 2.1 Finishes to floors and stairs.
- 2.2 Internal plastering.
- 2.3 Wall finishes other than plaster.
- 2.4 Decoration—Painting.

3. Installations series

- 3.1 Sanitation, drainage and refuse disposal.
- 3.2 Water supply—general.
- 3.3 General considerations relating to the use of energy.
- 3.4 Electrical, gas and mechanical installations.
- 3.5 Independent fires, stoves and appliances for solid and oil fuel

Beside the above a general Code of Functional Requirements of Buildings (with an Interim Series for small dwellings and schools) is in preparation. The following is a list of Codes and Draft Codes issued so far :

PUBLISHED CODES

The following had been published up to November, 1946 :
Parts of the Code of Functional Requirements for Buildings (Classification Code)

Chapter I (B)	Sunlight.	CP 5.	6d.
I (C)	Ventilation.	CP 6.	6d.
V	Loading.	CP 4.	2s. 0d.
VII (F)	Artificial Lighting.	CP 7.	2s. 0d

Protection of Structures against Lightning. CP 1. 3s. 6d. OP.
Heating and Hot Water Service Installations. CP 2. 1s. 0d.

DRAFT CODES

Drafts of the following have been circulated by the B.S.I. for the Codes of Practice Committee, pending publication of the final draft. Copies may be obtained from the B.S.I., except for those marked "OP." The B.S.I. Reference Number stated before the price and *not* the Code Number should be quoted when ordering, preceded by the letters CP (B).

Code of Functional Requirements for Buildings :

Chapter VII Services. 502. 2s. 0d.
VIII Heating and Heat Insulation. 309. O.P.
X Dirt and Vermin. 503. 1s. 0d.

Interim Code of Functional Requirements for Dwellings and Schools.

Chapter I (A) Daylight. 327. 2s. 0d.
III Precautions against Noise. 231. 2s. 0d.
IV Precaution against Fire. O.P.

General Series Codes

1. Carcase Series :

1.1. *Foundations and substructures.* 491. 2s. 0d.
1.24, 1.241, 1.242, 1.243. *Structural recommendations for load-bearing walls.* 537. 2s. 0d.
1.21, 1.211. *The structural use of steel in buildings.* 565. 3s. 0d.
1.213. *The structural use of tubular steel in buildings* (tentative). 611. 2s. 0d.
1.22. *Structural use of normal reinforced concrete in buildings.* 566. 3s. 0d.
1.31. *Brickwork.* 551. 3s. 6d.
1.412. *Roof Tiling.* 586. 2s. 0d.

2. Finishing Series :

2.12. *Concrete laid jointless on a concrete base.* 527. 2s. 0d.
2.134. *Composition block flooring.* 528. 1s. 0d.
2.144. *Cement-bitumen mixtures for flooring.* 543. 1s. 0d.
2.147. *Calcium sulphate flooring.* 529. 2s. 0d.
2.151. *Linoleum and cork carpet.* 530. 1s. 0d.
2.2. *Internal plastering.* 481. 2s. 0d.
2.21. *Preparation of surfaces for plaster.* 482. 2s. 0d.
2.22. *Lime plastering.* 483. 2s. 0d.
2.23. *Calcium sulphate plastering.* 536. 2s. 0d.
2.24. *Cement finishes.* 484. 2s. 0d.
2.4. *Decoration painting.* 559. 2s. 0d.
2.41. *Painting staining and varnishing wood and preservative treatment.* 542. 1s. 0d.
2.42. *Painting and distempering wall and ceiling boards and slabs.* 607. 1s. 0d.
2.44. *Painting and distempering plaster, concrete, brick and stone.* 608. 1s. 0d.

3. Installations Series :

3.132. *Sewers and drains.* 587. 2s. 0d.
3.133. *Concreting sewers and drains.* 588. 1s. 0d.
3.135. *Sewer connections.* 589. 1s. 0d.
3.4101. *Private electric generating plant.* 560. 2s. 0d.
3.4111. *Electricity service cables for small houses.* 531. 1s. 0d.
3.4113. *Consumers electric supply controls.* 532. O.P.
3.4131. *Provision of electric light in dwellings.* 549. 2s. 0d.
3.416. *Lightning protection.* 533. 2s. 0d.
3.421. *Installation of gas service pipes.* 434. 2s. 0d.
3.4211. *Gas metering and service control.* 435. 2s. 0d.
3.422. *Gas service pipes.* 436. 2s. 0d.
3.4231. *Gas lighting.* 479. 2s. 0d.
3.4232. *Hot water supply by gas.* 489. 2s. 0d.
3.42321. *Ditto for schools.* 550. 2s. 0d.
3.4234. *Gas cooking installations.* 462. 1s. 0d.
3.4235. *Gas refrigerators.* 459. 1s. 0d.
3.4236. *Flues for gas appliances.* 480. 2s. 0d.
3.4237. *Installation of gas heating appliances for laundering etc.* 582. 2s. 0d.
3.431. *Centralised domestic hot water service.* 526. 5s. 0d.
3.433. *Space heating by independent gas appliances (single family dwellings).* 437. 2s. 0d.
3.45. *Passenger electric lifts.* 552. 2s. 0d.
3.6. *Electrical Installations (General).* 625. 3s. 6d.
3.63. *Electric Wiring Systems in Buildings.* 627. 2s. 0d.
3.6412. *Installation of electric light in schools.* 610. 2s. 0d.
3.6431. *Installation of domestic electric cookers.* 609. 1s. 0d.
3.6443. *Installation of domestic electric refrigerators.* 590. 1s. 0d.

Orders for any of the above should be sent to the British Standards Institute, 28, Victoria Street, London, S.W.1 (Tel. Abbey 3333). Further information may be obtained from the Codes of Practice Committee, Ministry of Works, 42, Onslow Gardens, London, S.W.7. (Tel. Kensington 8161.)

SCALES OF PROFESSIONAL CHARGES

THE ROYAL INSTITUTE OF BRITISH ARCHITECTS

(As revised January, 1946.)

I. CONDITIONS OF ENGAGEMENT AND PRINCIPLES TO BE OBSERVED IN INTERPRETING THE SCALE

(*a*) Members of the R.I.B.A. are governed by the Charters, Byelaws and Code of Professional Practice of the Royal Institute.

(*b*) The Architect shall give such periodical supervision and inspection as may be necessary to ensure that the works are being executed in general accordance with the contract; constant supervision does not form part of the duties undertaken by him.

(*c*) In cases where constant superintendence is required a Clerk of Works shall be employed for this purpose. He shall be nominated or approved by the Architect, and appointed and paid by the Client. He shall be under the Architect's direction and control.

(*d*) The Architect shall not make any material deviation, alteration, addition to or omission from the approved design without the knowledge and consent of the Client.

(*e*) The Architect has authority to give orders on behalf of the Client if such are necessitated by constructional emergencies, provided that the Contract Sum shall not thereby be materially increased and the Client shall be notified thereof.

(*f*) The Architect shall, if requested to do so, at the completion of the work, supply free of charge to the Client, drawings sufficient to show the main lines of drainage and other essential services. Copyright in all drawings and in the work executed from them will remain the property of the Architect.

(*g*) The following Architects' charges do not include for Surveyors' work for which see clauses 9 to 15 which are those of the Royal Institution of Chartered Surveyors adopted by the R.I.B.A.

(*h*) The employment of Consultants shall be at the Architect's discretion in agreement with the Client and the payment of their fees shall be a matter of arrangement between Architect and Client.
Where it is agreed to retain the services of a Consultant in no case shall the Architect's fee be reduced by more than 2 per cent on the cost of the work upon which the services of the Consultant are retained, provided always that the Architect's fee on the cost of the whole scheme shall not be reduced by more than one per cent.

(*i*) An engagement entered into between the Architect and the Client may be terminated at any time by either party upon reasonable notice being given.

2. FEES

(*a*) NEW WORKS

For taking the Client's instructions, preparing sketch design, making approximate estimate of cost by cubic measurement, or otherwise, preparing drawings and specifications for the purpose of obtaining tenders, advising on tenders and preparation of contract, selecting and instructing Consultants (if any), furnishing to the Contractor two copies of the contract drawings and specification and such further details as are necessary for the proper carrying out of the works, general supervision as above defined, issuing certificates for payment, and passing and certifying accounts, the charge in respect of new works exclusive of the services enumerated in Clause 2(h) is to be a percentage on the total cost of all executed works or orders as follows :—

(i) If the contract and/or order exceeds £2,000 the percentage is 6 per cent.

(ii) If the contract and/or order does not exceed £2,000 the percentage is 10 per cent in the case of works costing £100 graduated to 6 per cent in the case of works costing £2,000 as the special character of such works may render appropriate.

(iii) These percentages apply to the great bulk of an Architect's work but the charge may be reduced to 5 per cent in the case of extensive works of a simple character which involve continuous repetition of units.

(*b*) ALTERATIONS AND ADDITIONS

In the case of alterations of and additions to existing buildings a higher percentage may be charged, not exceeding twice the amount due under Clause 2 (a) for new works of the same cost.

(*c*) FITTINGS, DECORATIONS, ETC.

In works in which designs for fittings, furniture, appointments, decorations, garden work or complex detail or construction are main features, special fees will be charged adequate to the circumstances.

(*d*) OMITTED WORKS

In addition to a percentage on the total cost of executed works, the Architect is entitled to charge in respect of all works included in the tender and/or order, but subsequently omitted not being merely provisional or contingent sums, two-thirds of the charge due upon them had they been executed.

(e) PARTIAL SERVICE

If the project or part of it be abandoned or deferred, or if the services of the Architect are dispensed with the charges in respect of the abandoned or deferred project or services for which the Architect was employed are as follows :—

(i) For taking Client's instructions and preparing preliminary sketch plans to illustrate possibilities of a site or cost of a scheme the charge is on *quantum meruit*.

(ii) For taking Client's instructions, preparing sketch design sufficient to indicate the Architect's interpretation of the Client's instructions (but not in detail adequate to enable quantities to be prepared) and making approximate estimate of cost, the charge is on *quantum meruit* and should not exceed one-sixth of the percentage stated in Clauses 2 (a) or 2 (b) (as the case may be) on the estimated cost of such works.

(iii) For taking Client's instructions, preparing sketch design, making approximate estimate of cost by cubic

measurement, or otherwise, and preparing drawings and particulars sufficient to enable quantities to be prepared by an independent Quantity Surveyor or a tender obtained, the charge is two-thirds of the percentage stated in Clauses 2 (a) or 2 (b) (as the case may be) on the estimated cost of such works.

(iv) For the purpose of this clause a project shall be deemed to have been abandoned or deferred if either (*a*) the client notifies the Architect to that effect, or (*b*) no contract has been entered into or order given for the works within six months of the completion by the Architect of the work described in the last preceding sub-clause.

(*f*) MODE AND TIME OF PAYMENT

The Architect is entitled to payment in stages as follows :—

(i) For the services described in Clause 2 (e) (i) forthwith upon completion of such work.

(ii) For the services described in Clause 2 (e) (ii) forthwith upon the completion of such work.

(iii) During the preparation of the working drawings referred to in Clause 2 (e) (iii), instalments of the fees set out in that Clause dependent upon the amount of work completed.

(iv) For the services described in Clause 2 (e) (iii) forthwith upon signing of a contract, or the giving of an order, or the abandonment or deferring of the work, less any payments already received by him pursuant to the last three preceding sub-clauses.

(v) For the remainder (if any) of the services payment shall be made by instalments from time to time as the work of supervision proceeds.

(*g*) WORK EXECUTED WITH OLD MATERIALS, ETC.

When work is executed wholly or in part with old materials, or where material, labour or carriage is provided by the Client, the percentage shall be calculated as if the works had been executed throughout by a Contractor, and with new material.

(*h*) SERVICES NOT INCLUDED IN PERCENTAGE

Additional charges are to be made in accordance with the amount of work involved for :—

(i) Advising as to the selection and suitability of sites. Negotiating as to sites or buildings. Surveying sites or buildings and taking levels, and making surveys, measurements, and plans of existing buildings.

(ii) The preparation of further sketch designs necessitated by a material alteration in, or addition to the Client's instructions, or altering the working drawings and specification in consequence thereof prior to the commencement of the works. Altering drawings, or preparing new drawings, and other services occasioned by variations or additions required by the Client after the commencement of the works. Making additional drawings for the use of the Client, Clerk of Works, Contractors, or Sub-Contractors, drawings for and negotiating with ground landlords, adjoining owners, public authorities, licensing authorities or others.

Services in respect of :—

(iii) Party Walls, Rights of Light and other easements, reservations or restrictions.

(iv) Litigation, arbitration, or valuation.

(v) Delay in building operations by causes beyond the control of the Architect, such as *force majeure*, bankruptcy, obstruction by parties.

3. SURVEYS

For making inspection, preparing report or giving advice on the structural or sanitary condition of premises, the charge is by time in accordance with Clause 7, the minimum fee being 3 guineas in addition to the cost of assistance.

4. LITIGATION AND ARBITRATION

For qualifying to give evidence, settling proofs, conferences with Solicitors and Counsel, attendance in Court or before Arbitrations or other tribunals, and for services in connection with litigation, the charge is based upon the time occupied, but is in no case to be less than 7 guineas per day.

Architects acting as Arbitrators are recommended to base their charges upon the total time occupied in dealing with a case at the rate of 2 guineas an hour exclusive of out-of-pocket expenses and other disbursements.

5. DILAPIDATIONS

For estimating dilapidations and furnishing or checking a schedule of the same, the charge is 5 guineas per cent on the sum agreed, the minimum fee being 5 guineas. For negotiating settlement of claim and for other services, the charge is by time in accordance with Clause 7.

6. TRAVELLING TIME

An additional charge may be made if the work should be at such a distance as to lead to an exceptional expenditure of time in travelling.

7. TIME CHARGES

In cases in which charges are based upon time occupied the minimum fee is 7 guineas per day exclusive of charges for Assistants' time.

8. EXPENSES

The foregoing Scale is, in all cases, exclusive of the cost of appliances, copies of documents, lithography, travelling and hotel expenses and all other reasonable disbursements, which are to be charged in addition.

Note.—The following Clauses are sanctioned by the Royal Institution of Chartered Surveyors and are adopted by the Royal Institute of British Architects.

9. FOR APPROVING PLANS SUBMITTED BY LESSEES AND INSPECTING BUILDINGS DURING PROGRESS

One guinea per cent up to £20,000 on the estimated cost of each building. Half a guinea per cent on the residue. (Minimum fee, 3 guineas.)

10(a) LEVELLING, PREPARING DRAWINGS AND SETTING OUT ESTATES FOR ROAD-MAKING, DRAINAGE, ETC., AND SUPERINTENDING THE EXECUTION OF THE WORKS

The charge for the preparation of a general development scheme must necessarily vary with the character and size of the estate. For Road Construction, the preparation of drawings and specifications, obtaining the approval of the Authority, obtaining tenders and superintending construction of roads and sewers, 5 per cent upon the outlay.

Note.—Where the work is not proceeded with, half the above scale will be charged.

(*b*) FOR LAND SURVEYING AND THE PREPARATION OF PLANS AND MAPS

Fee by arrangement depending on the intricacy of the work.

11. PREPARING BILLS OF QUANTITIES AND VALUING WORK EXECUTED

Note.—The following Scale is to be read in conjunction with the " Principles " issued by the Royal Institution of Chartered Surveyors.

The Scale of Charges for the preparation of Bills of Quantities set out in I (a) below is an over-all Scale, based upon the inclusion of all provisional amounts which do not normally call for measurement.

The measurement and valuation of variations and the preparation of statements of account at the conclusion of the works are separate services for which the Scale set out in (b) provides.

I. LUMP SUM CONTRACTS : ARCHITECTURAL WORK

When acting in the capacity of a Quantity Surveyor in connection with :—

(*a*) Taking out and preparing Bills of Quantities :—

(i) Basic Scale.—2½ per cent upon the estimated cost of the work up to £10,000.

2 per cent upon the balance above £10,000.

(ii) Works of Alteration.—The charges in sub-paragraph (i) shall be increased by ½ per cent in respect of works of alteration.

(iii) Generally.—Fees are to be calculated upon the basis of the accepted tender for the whole of the work. In the event of no tender being accepted, fees are to be calculated upon the basis of the lowest original *bona fide* tender received. In the event of no tender being received, the fees are to be calculated upon a reasonable valuation of the work, based upon the original Bills of Quantities.

In calculating the amount on which fees are payable, the total of the Credit Bill (if any) and the total of any Alternative Bills are to be added, but any Omission Bill forming part of an Alternative Bill is not to be included unless actual measurement is necessary to arrive at the omission.

The cost of lithographing or printing the Bills of Quantities is not included in the above Scale, but is to be charged in addition at the net amount payable to the lithographer or printer.

(*b*) Measuring and making up accounts of variations upon Contracts, including pricing and agreeing totals with Contractors :—

2½ per cent upon the amount of the additions, and 1½ per cent upon the amount of the omissions, less the total of Provisional sums or work omitted as a whole. No charge shall be made for the adjustment of provisional lump sums in cases where the exercise of professional skill is not involved.

(*c*) Taking out and preparing Bills of Quantities, or measuring for and making up accounts of decoration contracts :—

2 per cent above the rates in the foregoing paragraphs.

(*d*) Estimating upon Bills of Quantities :—

½ per cent.

(*e*) Preparing approximate Quantities and estimating upon same :—

½ per cent upon the estimated cost, or, alternatively, a charge to be based upon the time involved.

(*f*) Surveying work in progress, taking particulars and reporting for Interim Certificates :—

½ per cent upon the amount of each valuation less the amount of any previous valuation or valuations upon which fees shall have been paid, or alternatively a charge to be based upon the time involved.

(*g*) Taking particulars on site and writing specifications for works of alteration or repair, including supervision if required :—

7½ per cent upon the amount expended, or alternatively, a charge to be based upon the time involved.

Note.—In cases where any of the materials used in construction are supplied by the building owner, the percentage charge to be made upon the estimated or actual value thereof.

II. SCHEDULE CONTRACTS : ARCHITECTURAL WORK

Preparing, pricing and agreeing schedules of prices :—

A charge to be based upon the time involved.

Measuring under Schedule and making up accounts, including pricing and agreeing totals :—

2½ per cent upon the gross amount of the account.

The above percentage applies only to the complete measurement and valuation of the buildings or building operations when undertaken as a whole and included in one account. When the measurement proceeds by stages involving the preparation of periodical bills, then the percentage charge shall be increased by ½ per cent.

Note.—In cases where any of the materials used in construction are supplied by the building owner, the percentage charge to be made upon the estimated or actual value thereof.

III. PRIME COST CONTRACTS

Checking prime costs in " Costs plus Profit " Contracts and making up final accounts of works executed :—

1½ per cent except on work necessitating measurement which is to be paid for at the rates previously laid down.

12. VALUATION OF FREEHOLD, COPYHOLD OR LEASEHOLD PROPERTY

One guinea per cent on the first £1,000. Half-a-guinea per cent on the next £9,000. And a quarter guinea per cent on the residue.

Note.—In valuations for mortgage, if an advance is not made one-third of the above charges, with a minimum fee of 5 guineas, may be made provided that the intending mortgagee is informed of the arrangement.

13. WORK UNDER THE LANDS CLAUSES CONSOLIDATION ACT OR OTHER ACTS FOR THE COMPULSORY ACQUISITION OF PROPERTY

(*a*) To the Valuer who prepares the case (including negotiation for a settlement where required), one-third additional to the scale set out below.

(*b*) To any additional Valuer who qualifies to give evidence, the scale set out below.

Amount	Gns.	Amount	Gns.	Amount	Gns.	Amount	Gns.
£		£		£		£	
100	5	2400	25	5600	41	8800	57
200	7	2600	26	5800	42	9000	58
300	9	2800	27	6000	43	9200	59
400	11	3000	28	6200	44	9400	60
500	13	3200	29	6400	45	9600	61
600	14	3400	30	6600	46	9800	62
700	15	3600	31	6800	47	10000	63
800	16	3800	32	7000	48	11000	68
900	17	4000	33	7200	49	12000	73
1000	18	4200	34	7400	50	14000	83
1200	19	4400	35	7600	51	16000	93
1400	20	4600	36	7800	52	18000	103
1600	21	4800	37	8000	53	20000	113
1800	22	5000	38	8200	54	Half a Guinea per cent on the remainder	
2000	23	5200	39	8400	55		
2200	24	5400	40	8600	56		

Where works of reinstatement are negotiated by the Surveyor the cost of these works should be taken into account in calculating the fee ; and any amount set off in respect of Betterment should be added to the amount of settlement for that purpose.

Note.—This Scale, known as Ryde's Scale, does not apply to Arbitrators or Umpires, nor in cases of easement. It is exclusive of attendance on Juries or Umpires or at Arbitrations, in respect of which the minimum fee is 5 guineas per diem.

14. SALES OF FREEHOLD AND COPYHOLD ESTATES AND HOUSES AND GROUND LEASES

Negotiating a sale by private contract or introducing a purchaser :—

5 per cent on the first £300.
2½ per cent on the next £4,700.
1½ per cent on the residue.

15. EFFECTING A PURCHASE

(Including advising as to value if required.) One half the fee charged on sales.

Note.—When more than one property has been reported upon, an extra fee will be chargeable. Where no purchase is effected, the usual fee for valuation should be charged. 22nd July, 1933.

SCALE OF ARCHITECTS' FEES FOR STATE-AIDED HOUSING SCHEMES

(Excluding Multi-storey Flats)

Note.—This Scale does not include fees for quantity surveying services. A copy of the Scale of Charges for Quantity Surveyors' Services in connection with Housing Schemes is attached. The Ministry of Health have agreed to sanction fees in accordance with these two Scales.

Having regard to the desirability of employing architects for the design of houses of the smaller type likely to be erected by local authorities and Public Utility Societies and to aid in the solution of the housing problem generally, the R.I.B.A. have drawn up a special Scale of Charges relating thereto.

It is essentially in the interest of all parties that the architect should be charged with control throughout all stages of the scheme in order that his designs, drawings and specifications may be adequately interpreted.

The scale throughout is exclusive of reasonable travelling and out-of-pocket expenses and printers' charges for additional copies of drawings and documents.

The scale applies to a State-aided Housing Scheme (not including multi-storey flats) to be carried out on one site and executed continuously under one commission.

(*a*) LAY-OUT

For taking instructions, negotiating with Ministries, Government Departments, Regional and local authorities including the preparation of two copies of drawings required, preparing preliminary sketch to, 1/2500 scale and finished drawing of the lay-out to 1/500 scale and, where the architect is employed to do this work in conjunction with the planning of the houses, the fees are to be :—

For the first	4	dwellings	£2	0	0	a dwelling
,, next	6	,,	£1	15	0	,,
,, ,,	15	,,	£1	10	0	,,
,, ,,	25	,,	£1	5	0	,,
,, ,,	25	,,	£1	2	6	,,
,, ,,	25	,,	£1	0	0	,,
,, ,,	25	,,		17	6	,,
For the next	25	dwellings		15	0	a dwelling
,, ,,	25	,,		12	6	,,
,, ,,	25	,,		10	0	,,
,, ,,	25	,,		7	6	,,
All over	225	,,		5	0	,,

(*b*) CONSTRUCTIONAL WORK FOR ROADS AND SEWERS

For making constructional drawings of the roads and sewers and preparing specification from a standard specification the fees are to be :—

£1 15 0 a dwelling

If general supervision by the architect is required this charge is to be increased to £2 5 0 a dwelling.

(*c*) HOUSE DESIGN

(i) For taking instructions, preparing sketch plans, submitting to Committee, making variations to suit requirements and re-submitting, preparing specification, ⅛″ scale and ½″ scale working drawings and full size details of the approved designs, submitting plans to the local authority as required by building regulations and supplying two copies of these documents for the use of the main contractors.

(ii) Obtaining quotations for P.C. sums, obtaining tenders from contractors, submitting tenders to the Committee and advising the Committee on the contract.

(iii) Supplying instructions to the contractors as provided for in the Conditions of the Building Contract, general supervision of the work but not constant superintendence, reporting to the Committee on the progress of the work, instructing Clerk of Works, issuing certificates, making out report under the maintenance clause of the contract and settling final accounts.

The fees for the services in paragraphs (i), (ii) and (iii) are to be :—

For the first	4	dwellings	£22	a dwelling
,, next	6	,,	£20	,,
,, ,,	15	,,	£18	,,
,, ,,	25	,,	£16	,,
,, ,,	25	,,	£14	,,
,, ,,	25	,,	£12	,,
,, ,,	25	,,	£10	,,
,, ,,	25	,,	£9	,,
,, ,,	25	,,	£8	,,
,, ,,	25	,,	£7	,,
,, ,,	25	,,	£6	,,
All over	225	,,	£5	,,

It is the intention that a reasonable number of different designs shall be included in this scale up to a number not exceeding 10 designs in the larger number of dwellings.

In the case of 4 dwellings, two different designs are to be provided if required, and in the case of 6 dwellings three different designs are to be provided if required.

If the architect is not required to perform the services set out in paragraph (iii) the fee is to be 60 per cent of the total fee under this Clause.

If the architect is not required to perform the services set out in paragraphs (ii) and (iii) the fee is to be 50 per cent of the total fee under this Clause.

(*d*) ADDITIONAL SERVICES NOT INCLUDED UNDER (*a*), (*b*) AND (*c*) ABOVE

The following services for which the architect may be employed will be charged on a *quantum meruit* basis :—

Negotiations relating to the site.
Making surveys, measurements and plans of the site or existing buildings and taking levels.
Making drawings for and negotiations with Ground Landlords and Public Authorities not referred to above.
Making arrangements in respect of party-walls, rights of light and other easements.
Additional work involved where the work is carried out under more than one building contract.
Making extra drawings for the client, contractors, subcontractors or Clerks of Works' use.
Work in connection with litigation and arbitration.

(e) ABANDONED WORKS

Where any of the architect's services have been rendered under Sections (*a*)–(*c*) of this scale and the whole or part of the proposed scheme is subsequently abandoned, reduced fees shall be payable in accordance with the amount of work done.

Note.—At their meeting on 10th April, 1945, the Council considered a report of the Practice Committee in which it was stated that communications from members and from local authorities had been received pointing out that in the case of housing in rural areas where the houses were on many scattered sites Clause (*c*) of the Scale of Fees for State-Aided Housing Schemes as approved by the Council on 16th May, 1944, provided a fee which was high in comparison with the fee which would be payable if the houses were on one site.

On the recommendation of the Practice Committee the Council have decided that in the case of rural housing undertaken for one local authority by one architect, where the houses come within an area of a radius of approximately five miles the housing may be considered to be on one site and Clause (*c*) of the Scale of Fees for State-Aided Housing Schemes applied accordingly.

This modification of the scale applies to Clause (*c*) only.

This Scale was first issued by the Council on 16th May, 1944, and amended on 19th June, 1945.

THE CHARTERED SURVEYORS' INSTITUTION
(Incorporated by Royal Charter)

SCALE OF CHARGES FOR QUANTITY SURVEYORS' SERVICES IN CONNECTION WITH HOUSING SCHEMES

The following Scale of Charges is applicable to work in Housing Schemes inside the curtilage of the houses. It is not applicable to Site Works, Roads, Paths, Main Drains, Sewers and other works outside the curtilage of the houses.

1 (*a*) For the preparation of Bills of Quantities for foundations and super-structures of houses, and including paths, fences, drains and external services within the curtilage of the houses :—

For the first	4	dwellings in a scheme,	£12	per dwelling
„ next	6	„ „ „	£11	„
„ „	15	„ „ „	£10	„
„ „	25	„ „ „	£9	„
„ „	25	„ „ „	£8	„
„ „	25	„ „ „	£7	„
„ „	25	„ „ „	£6	„
„ „	25	„ „ „	£5	„
„ „	25	„ „ „	£4	„
„ „	50	„ „ „	£3	„
All over	225	„ „ „	£2	„

(*b*) The foregoing scale of charges includes for valuing and reporting for interim certificates, and envisages a reasonable number of different types of houses in each scheme.

(*c*) A scheme, for the purposes of computing the fee, shall be regarded as a group of houses on one site and where one contractor is employed. Separate contracts on one site, and contracts let on separate sites, shall each be regarded as separate and distinct schemes.

2 (*a*) For measuring and making up accounts of variations upon the contract, including pricing and agreeing totals with the contractor :—

1½ per cent upon the gross amount of additions on all houses.

1 per cent upon the gross amount of omissions on all houses, less the total of provisional sums or work omitted as a whole.

(*b*) No charge shall be made for the adjustment of provisional lump sums in cases where the exercise of professional skill is not involved.

3 For adjusting variations of price arising under any Variation of Price (Labour and Materials) Clauses of the contract, or the application of the Uniformity Agreement, or the Essential Work Order or any other agreement or order necessitating an adjustment of the contract sum :—

2½ per cent upon the aggregate of the amount of the increases and/or decreases.

4 (*a*) The foregoing fees are in all cases exclusive of travelling expenses and lithography or other charges for copies of documents ; the net amount of such expenses and charges to be paid for in addition. Subsistence expenses, if any, to be charged by arrangement.

(*b*) In cases where any of the materials used in construction are supplied by the building authority or owner, the estimated or actual value thereof is to be included in the total on which the fee is calculated.

September, 1945.

THE CHARTERED SURVEYORS' INSTITUTE

(Incorporated by Royal Charter)

TAXATION OF FEES

When acting in cases where the Surveyor's fees may be the subject of taxation, Members are advised to make arrangements beforehand for the payment of the proper Scale fees.

Fees included in the following Scale are in all cases exclusive of travelling and other expenses, disbursements, plans, copies of documents, and lithography.

Where one Valuer acts between both parties the minimum charge shall be Scale and a half divisible between both parties.

1. VALUATION OF FREEHOLD, COPYHOLD OR LEASEHOLD PROPERTY

One guinea per cent on the first £1,000 of the valuation. Half a guinea per cent on the next £9,000 of the valuation. And a quarter-guinea per cent on the residue of the valuations.

Note.—In valuations for mortgage, if an advance is not made, one-third of the above charges, with a minimum fee of 5 guineas, may be made provided that the intending mortgagee is informed of the arrangement.

2. VALUATION OF FURNITURE, FIXTURES, TRADE STOCKS AND EFFECTS

Five guineas per cent up to £500 and 2½ guineas per cent on the residue.

3. VALUATION OF PLANT AND MACHINERY

2½ Guineas per cent on first £500.
1½ Guineas per cent on next £4,500.
1 Guinea per cent. on next £5,000.
Over £10,000 by arrangement.
The valuation fee to include inventory (Minimum Fee, 5 guineas).

4. VALUATION OF HOTEL AND PUBLIC HOUSE FIXTURES, FITTINGS AND CONTENTS

5 guineas per cent on the amount of the valuation as settled.

5. WORK UNDER THE LANDS CLAUSES CONSOLIDATION ACT OR OTHER ACTS FOR THE COMPULSORY ACQUISITION OF PROPERTY

(*a*) For Qualifying to give Evidence.

Amount	Gns.	Amount	Gns.	Amount	Gns.	Amount	Gns.
£		£		£		£	
100	5	2,400	25	5,600	41	8,800	57
200	7	2,600	26	5,800	42	9,000	58
300	9	2,800	27	6,000	43	9,200	59
400	11	3,000	28	6,200	44	9,400	60
500	13	3,200	29	6,400	45	9,600	61
600	14	3,400	30	6,600	46	9,800	62
700	15	3,600	31	6,800	47	10,000	63
800	16	3,800	32	7,000	48	11,000	68
900	17	4,000	33	7,200	49	12,000	73
1,000	18	4,200	34	7,400	50	14,000	83
1,200	19	4,400	35	7,600	51	16,000	93
1,400	20	4,600	36	7,800	52	18,000	103
1,600	21	4,800	37	8,000	53	20,000	113
1,800	22	5,000	38	8,200	54	Half a Guinea per cent on the remainder.	
2,000	23	5,200	39	8,400	55		
2,200	24	5,400	40	8,600	56		

Where works of reinstatement are negotiated by the Surveyor the cost of these works should be taken into account in calculating the fee ; and any amount set off in respect of Betterment should be added to the amount of settlement for that purpose.

Note.—This Scale, known as Ryde's Scale, does not apply to Arbitrators or Umpires, nor in cases of easement. It is exclusive of attendance on juries or Umpires or at Arbitrations, in respect of which the minimum fee is 5 guineas per diem.

(*b*) To the Valuer preparing the Case.
(Including negotiation for a settlement where required.)
One-third additional to the Scale shown under (*a*).

6. VALUATION FOR PROBATE OR ESTATE DUTY

Freehold, Copyhold and Leasehold Property.
1 guinea per cent on first £1,000 of the valuation, ½ guinea per cent on next £4,000, ¼ guinea per cent on residue.
(Minimum Fee, 5 guineas.)

Personal Property
5 guineas per cent on the first £100 of the valuation, 2½ guineas per cent on next £400, and 1½ guineas per cent on the residue (to include the inventory).
(Minimum Fee, 5 guineas)

Note.—This Scale (No. 6) does not apply to contested cases.

7. VALUING FOR ANNUAL RENTAL

Agricultural Property
7½ guineas per cent up to £250, 5 guineas per cent on next £250, 2½ guineas per cent on residue.
(Minimum Fee, 5 guineas)

Business and Residential Property
5 guineas per cent up to £300, 2½ guineas per cent on residue.
(Minimum Fee, 5 guineas)

8. VALUATION FOR RATING PURPOSES OF SINGLE PROPERTIES

For valuations for Ratepayers, Rating Authorities, Assessment Committees, or County Valuation Committees, a valuation fee upon the following scale :—

Net Annual Value					
Not exceeding £1,000	2 guineas	per	cent	plus 5 guineas	
Exceeding £,1000 and not exceeding £5,000	2	,,	,,	,,	with a minimum fee of 25 guineas
Exceeding £5,000 and not exceeding £10,000 ...	2 guineas	per	cent	upon	£5,000
	1½	,,	,,	,,	the residue
Exceeding £10,000 and not exceeding £20,000 ...	2	,,	,,	,,	£5,000
	1½	,,	,,	,,	£5,000
	1¼	,,	,,	,,	the residue
Exceeding £20,000	2	,,	,,	,,	£5,000
	1½	,,	,,	,,	£5,000
	1¼	,,	,,	,,	£10,000
	1	,,	,,	,,	the residue

For valuations for Ratepayers, the Net Annual Value for the purposes of this Scale of Fees is the Net Annual Value in the Valuation List at the time when objection is lodged. For valuations for a Rating Authority or an Assessment Committee, the Net Annual Value is the Net Annual Value finally determined by the Assessment Committee.

Note.—In addition to the above scale a fee of 5 guineas per day in respect of attendance before Assessment Committees and 10 guineas per day for attendance before Quarter Sessions.

9. FARM VALUATIONS

(*a*) For Valuing Live and Dead Farming Stock, Agricultural Plant, Fixtures and Growing Crops :—
 5 guineas per cent on the first £100.
 2½ guineas per cent on the residue.

(*b*) For Valuing Ordinary Farm Tenant Right (not including the above) :—
 5½ guineas up to £100.
 2½ guineas per cent on next £900.
 1½ guineas per cent on the residue.

The above charges (*a*) and (*b*) are to be calculated on the Gross amount of a valuation before any deductions are made therefrom for dilapidations or other matters dealt with, and are not intended to cover the preparation and adjustment of Claims for disturbance under the Agricultural Holdings Acts, or other special matters, for which an additional charge commensurate with the amount of work involved is to be made.

(*c*) For Settling Dilapidations to Buildings, Land, etc.—
 5 guineas per cent on amount of the settlement.

10. MARKING, VALUING AND SELLING TIMBER AND UNDERWOOD

5 guineas per cent on the amount realised.
When Valuing only :—
 5 guineas per cent on £500.
 2½ guineas per cent on residue.

11. SALES OF FREEHOLD AND COPYHOLD ESTATES AND HOUSES AND GROUND LEASES

(*a*) Negotiating a Sale by Private Contract or introducing a Purchaser.
 5 per cent on first £300.
 2½ per cent on next £4,700.
 1½ per cent on residue.

(*b*) Sales by Auction.
(Including advising as to reserves).
Commission same as in (*a*) for Sale by Private Contract.

Sale before Auction.
After issue of advertisements Commission same as in (*a*).

Non-Sale.
In the event of non-sale at the Auction a fee, the amount of which is a matter of arrangement, shall be payable.

Sale after Auction.
In the event of the property being sold within three months after the Auction, the charges on non-sale would merge into the ordinary commission then payable.

Notes.—(1) In addition to the above charges, whether under (*a*) or (*b*), a commission on the amount paid for chattels, other moveable effects, timber and tenant-right, of 5 per cent on £500 and 2½ per cent on residue (to include inventory and valuation if required) is payable.

(2) Where the division of an estate into a number of lots involves substantial additional work there shall be an increased remuneration to be arranged between the vendor and auctioneer.

(3) In cases where two agents are co-operating at the request of the owner, the commission shall be at the rate of Scale and a quarter.

12. EFFECTING A PURCHASE

(Including advising as to value if required.)
One-half the fee charged on Sales.

Note.—When more than one property has been reported upon, an extra fee will be chargeable.

Where no purchase is effected, the usual fee for valuation should be charged.

13. LETTING LAND ON A BUILDING LEASE

(*a*) On Ground Rents up to £50, one year's Ground Rent.
(*b*) On Ground Rents exceeding £50 and not exceeding £100—as in (*a*) on the first £50, plus 75 per cent on the residue.
(*c*) On Ground Rents exceeding £100 and not exceeding £1,000—as in (*b*) on the first £100, plus 50 per cent on the residue.
(*d*) On Ground Rents exceeding £1,000—as in (*c*) on the first £1,000, plus 25 per cent on the residue.

Where a premium is paid there would be payable 5 per cent on the first £1,000 and 2½ per cent on the balance.

14. THE ASSIGNMENT OF BUILDING AGREEMENTS AT A PREMIUM

One-half the scale charge for letting land on a building lease (No. 13 above), together with 5 per cent on the first £1,000 of the premium and 2½ per cent on the balance.

15. FOR APPROVING PLANS SUBMITTED BY LESSEES, AND INSPECTING BUILDINGS DURING PROGRESS

One guinea per cent up to £20,000 on the estimated cost of each building. Half guinea per cent on residue.
(Minimum Fee, 3 guineas.)

16. ESTATE AGENCIES AND COLLECTION OF RENTS OR TITHES

(Including Management, where required.)

Ground Rents :—
2½ to 5 per cent on the gross rental, according to the amount of the rents and number of collections.

Other property and tithes :—
5 per cent on the gross rental.

Agricultural property :—
7½ per cent on the gross rental.

Weekly property :—
10 per cent on the gross rental.

17. ON LETTING UNFURNISHED PREMISES OR DISPOSING OF LEASES OTHER THAN GROUND LEASES BY ASSIGNMENT OR OTHERWISE

(*a*) On Letting Unfurnished Premises.
If the Rent be £100 or less :—
Where the term is for One Year or less—5 per cent on One Year's Rent
Where the term is for more than One Year—7½ per cent on One Year's Rent.
If the Rent be over £100 the scale above shall apply to the first £100. On the excess rental over that amount :—
Where the term is for Three Years or less—5 per cent.
Where the term is for more than Three Years—7½ per cent.
In the case of Leases requiring the Lessee to undertake the Repair of the Demised Premises, the Commission shall be 10 per cent on One Year's Rent, whatever the term.

(*b*) Disposal of Leasehold Property.
On Disposing of all Leases (other than Ground Leases) by assignment or otherwise :—
On the Rent the same Commission as for a Letting.

(*a*) and (*b*)

In either of the above cases (*a*) and (*b*) upon the premium and any consideration which is equivalent thereto, a Commission of 5 per cent up to £1,000, and 2½ per cent on the residue ; and on any sum obtained for Fixtures, Furniture or Effects of any kind, a Commission of 5 per cent up to £500 and 2½ per cent on the residue. Should the rent be a progressive one, then the Commission is based on the average rent for the whole period of the term granted.

When a property, which an Agent has been instructed to let or sell, is let by him with an option to purchase, and the tenant afterwards exercises his option, the Commission for selling, less the Commission already paid on the letting, will then become payable.

18. ON LETTING FURNISHED PREMISES AND SPORTING RIGHTS, INCLUDING COLLECTION OF RENT

5 per cent on the first year's rental and 2½ per cent on the rental for the remainder of the term.

19. ON NEGOTIATING TENANCIES OF UNFURNISHED PREMISES

When Acting on Behalf of the Tenant

One-half the Scale on letting.

Note.—When more than one property has been reported upon, an extra fee is chargeable.

20. PREPARING SPECIFICATION OF DILAPIDATIONS AND SETTLING THE AMOUNT IF REQUIRED

5 guineas per cent on the amount of the settlement or on the estimated cost of complying with the Schedule. (Minimum fee, 5 guineas.)

21. LEVELLING, PREPARING DRAWINGS AND SETTING OUT ESTATES FOR ROAD-MAKING, DRAINAGE, ETC., AND SUPERINTENDING THE EXECUTION OF THE WORKS

The charge for the preparation of a general development scheme must necessarily vary with the character and size of the estate.

For Road Construction, the preparation of drawings and

specifications, obtaining the approval of the Authority, obtaining tenders and superintending construction of roads and sewers :—

5 per cent upon the outlay.

Note.—Where the work is not proceeded with, half the above scale will be charged.

22. FOR LAND SURVEYING AND THE PREPARATION OF PLANS AND MAPS

Fee by arrangement, depending on the intricacy of the work.

23. DESIGNING NEW BUILDINGS, ARCHITECTURAL WORK

The R.I.B.A. Scale, Section I of which is set out below:—

I. Fees on New Works

For taking the Client's instructions, preparing sketch design, making approximate estimate of cost by cubic measurement, or otherwise, preparing drawings and specifications for the purpose of estimates, obtaining tenders, advising on tenders and in preparation of contract, selecting and instructing Consultants, furnishing to the Contractor one copy of the drawings and specification and such other details as are necessary for the proper carrying out of the works, general supervision as above defined, issuing certificates for payment, and passing and certifying accounts, the charge in respect of new works is to be a percentage on the total cost of all executed works as follows :—

(*a*) If the contract or order exceeds £2,000 the percentage is to be 6 per cent.

(*b*) If the contract or order does not exceed £2,000 the percentage is to be 10 per cent in the case of works costing £100 graduated to 6 per cent in the case of works costing £2,000 as the special character of such works may render appropriate.

24. PREPARING BILLS OF QUANTITIES AND VALUING WORK EXECUTED

The Scale of Charges for the preparation of Bills of Quantities set out in I (*a*) below is an over-all Scale, based upon the inclusion of all provisional amounts which do not normally call for measurement.

The measurement and valuation of variations and the preparation of statements of account at the conclusion of the works are separate services for which the scale set out in I (*b*) provides.

I. Lump Sum Contracts : Architectural Work.

When acting in the capacity of a quantity surveyor in connection with :—

(*a*) Taking out and preparing Bills of Quantites :—

(i) Basic Scale.

2½ per cent upon the estimated cost of the work up to £10,000.

2 per cent upon the balance above £10,000.

(ii) Works of Alteration.

The charges in sub-paragraph (i) shall be increased by ½ per cent in respect of works of alteration.

(iii) Generally.

Fees are to be calculated upon the basis of the accepted tender for the whole of the work. In the event of no tender being accepted, fees are to be calculated upon the basis of the lowest original bona-fide tender received. In the event of no tender being received, the fees are to be calculated upon a reasonable valuation of the work, based upon the original Bills of Quantities.

In calculating the amount on which fees are payable, the total of the Credit Bill (if any) and the total of any Alternative Bills are to be added, but any Omission Bill forming part of an Alternative Bill is not to be included unless actual measurement is necessary to arrive at the Omission.

The cost of lithographing or printing the Bills of Quantities is not included in the above Scale, but is to be charged in addition at the net amount payable to the lithographer or printer.

(*b*) Measuring and making up accounts of variations upon Contracts, including pricing and agreeing totals with Contractors.

2½ per cent upon the amount of the additions and 1½ per cent upon the amount of the omissions, less the total of Provisional sums or work omitted as a whole. No charge shall be made for the adjustment of provisional lump sums in cases where the exercise of professional skill is not involved.

(*c*) Taking out and preparing Bills of Quantities, or measuring for and making up accounts of decoration contracts :—

2 per cent above the rates in the foregoing paragraphs.

(*d*) Estimating upon Bills of Quantities :—

½ per cent

(*e*) Preparing approximate Quantities and estimating upon same :—

½ per cent upon the estimated cost, or, alternatively, a charge to be based upon the time involved.

(*f*) Surveying works in progress, taking particulars and reporting for Interim Certificates :—

½ per cent upon the amount of each valuation less the amount of any previous valuation or valuations upon which fees shall have been paid, or alternatively a charge to be based upon the time involved.

(*g*) Taking particulars on site and writing specifications for works of alteration or repair, including supervision, if required :—

7½ per cent upon the amount expended, or alternatively, a charge to be based upon the time involved.

Note.—In cases where any of the materials used in construction are supplied by the building owner, the percentage charge to be made upon the estimated or actual value thereof.

II. Schedule Contracts : Architectural Work.

Preparing, pricing and agreeing schedules of prices :—

A charge to be based upon the time involved.

Measuring under Schedule and making up accounts, including pricing and agreeing totals :—

2½ per cent upon the gross amount of the Account.

The above percentage applies only to the complete measurement and valuation of the buildings or building operations when undertaken as a whole and included in one account. When the measurement proceeds by stages involving the preparation of periodical bills, then the percentage charge shall be increased by ½ per cent.

Note.—In cases where any of the materials used in construction are supplied by the building owner, the percentage charge to be made upon the estimated or actual value thereof.

III. Prime Cost Contracts

Checking prime costs in "Costs plus Profit" Contracts and making up final accounts of works executed :—

1½ per cent except on work necessitating measurement, which is to be paid for at the rates previously laid down.

IV. Civil Engineering Work

Generally speaking, the charges for services in relation to work which can be classed as Civil Engineering work, are, as regards the percentages, to be half those for Architectural work, but the same as the latter in respect of charges based upon time.

V. Litigation and Arbitration

For qualifying to give evidence ; settling proofs, conferences with solicitors and counsel ; attendance in the Courts or before Arbitrators, or other tribunals ; and for other services in connection with litigation and arbitration the charges are to be based upon the time involved, but are in no case to be less than a minimum of 5 guineas per day of not exceeding six hours.

THE AUCTIONEERS' AND ESTATE AGENTS' INSTITUTE OF THE UNITED KINGDOM

(Founded 1886)

29, Lincoln's Inn Fields, London, W.C.2.

This Scale accords with that authorised by the Chartered Surveyors' Institution.

The Scale is in all cases exclusive of travelling and other expenses, disbursements, plans, copies of documents and lithography.

I.

SALES BY AUCTION

On Sales by Auction of Freehold and Copyhold Estates and Houses, and Ground Leases, including the preparation of Particulars, and advising as to Reserves :—

On the first £300	5 per cent
On the next £4,700	2½ per cent
On the residue	1½ per cent

In cases where two Agents are co-operating at the request of the Owner, the Commission shall be at the rate of a Scale and a quarter.

Where the division of an Estate into a number of lots involves substantial additional work, there shall be an increased remuneration to be arranged between the Vendor and Auctioneer.

In addition to the above charges :—

On amounts paid by the purchaser for Chattels, Fixtures, Fittings, Trade Stocks, and other Moveable Effects, Timber, and Tenant right under the Conditions of Sale, in addition to the purchase-money of the Property :—

5 per cent on £500 and 2½ per cent on residue (to include inventory and valuation, if required).

Sale before Auction.

After issue of advertisements, the same scale as by Auction.

Non-Sale.

In the event of non-sale at the Auction, a fee, the amount of which is a matter of arrangement, is payable.

Sale after Auction.

In the event of the property being sold within three months after the Auction, the charges for non-sale would merge into the ordinary Commission then payable.

On Sales by Auction of Furniture, Trade Stocks and Chattels on the Vendor's premises.

5 per cent on the amount realised, exclusive of preparation of catalogues.

On Sales by Auction of Plant and Machinery.

5 per cent on the amount realised, exclusive of preparation of catalogues.

On Sales by Auction of Live and Dead Farming Stock, except Horses, Pedigree Live Stock, and Milk-Recorded Cattle.

2½ per cent on Live Stock, and 5 per cent on Dead Stock on the amount realised.

On Sales by Auction of Horses, Pedigree Live Stock, and Milk-Recorded Cattle.

5 per cent on the amount realised.

On Lots referred to in the last four paragraphs, reserved or bought in by or on behalf of the Vendor.

One-half the Commission on Sale, calculated on the amount of reserve or buying in price.

II.

PRIVATE TREATY SALES

Negotiating a Sale by Private Contract, or introducing a Purchaser, of Freehold and Copyhold Estates and House and Ground Leases :—

On the first £300	5 per cent
On the next £4,700	2½ per cent
On the residue	1½ per cent

and a Commission, in addition, on the amount paid for Chattels, Fixtures, Fittings, Furniture, Trade Stocks, and other Moveable Effects, Timber, and Tenant-right, of 5 per cent up to £500 and 2½ per cent on the residue (to include inventory and valuation, if required).

In cases where two Agents are co-operating at the request of the Owner, the Commission shall be at the rate of a Scale and a quarter.

III.

PURCHASES

Purchases of Freehold, Copyhold, or Leasehold Property.

One-half of the Scale for Sale by Private Treaty, calculated upon the amount of the purchase-money, but including inspection, advising as to value, and negotiating or bidding.

When the Agent is required to inspect more than one property, an extra fee is charged in respect of the surveys and reports upon these additional properties.

Where no purchase is effected, the usual Scale for Valuation should be charged.

IV.

(*a*) LETTINGS

On Letting Unfurnished Premises.

If the Rent be £100 or less :—

Where the term is for One Year or less—5 per cent on One Year's Rent.

Where the term is for more than One Year—7½ per cent on One Year's Rent.

If the Rent be over £100 the scale above shall apply to the first £100. On the excess rental over that amount :—

Where the term is for Three Years or less—5 per cent.

Where the term is for more than Three Years—7½ per cent.

In the case of Leases requiring the Lessee to undertake the Repair of the Demised Premises, the Commission shall be 10 per cent on One Year' Rent, whatever the term.

(*b*) DISPOSAL OF LEASEHOLD PROPERTY

On Disposing of all Leases (other than Ground Leases) by assignment or otherwise :—

On the Rent the same Commission as for a Letting.

and in addition

In either of the above cases (*a*) and (*b*), upon the premium and

any consideration which is equivalent thereto, a Commission of 5 per cent up to £1,000, and 2½ per cent on the residue ; and on any sum obtained for Fixtures, Furniture, or Effects of any kind, a Commission of 5 per cent up to £500, and 2½ per cent on the residue.

Should the rent be a progressive one, then the Commission, in cases (*a*) and (*b*) above, is based on the average rent for the whole period of the term granted.

When a property, which an Agent has been instructed to let or sell, is let by him with an option to purchase, and the tenant afterwards exercises his option, the Commission for selling, less the Commission already paid on the letting, will then become payable.

On Letting Furnished Premises, in Town or Country, or Sporting Rights, including Collection of Rent :—

5 per cent on the first year's rental, and 2½ per cent on the rental for the remainder of the term, or for any extension thereof.

For negotiating the Renting of Unfurnished Premises, excluding Survey or Valuation, when acting on behalf of the Tenant :—

Half the Commission payable for a letting.

When the Agent is required to inspect more than one property, an extra fee is charged in respect of the Surveys and Reports upon these additional properties.

For negotiating the Renting of Furnished Premises, excluding Survey or Valuation, when acting on behalf of the Tenant :—

Half the Commission payable for a Letting.

When the Agent is required to inspect more than one property, an extra fee is charged in respect of the Surveys and Reports upon these additional properties.

For making or checking Inventories of Furniture and Effects :—

A minimum fee of Two guineas per day, exclusive of expenses.

On Letting Land on Building Lease :—

(*a*) On Ground Rents up to £50—One year's Ground Rent.

(*b*) On Ground Rents exceeding £50 and not exceeding £100.

As in (*a*) on first £50, plus 75 per cent on the residue.

(*c*) On Ground Rents exceeding £100 and not exceeding £1,000. As in (*b*) on first £100, plus 50 per cent on the residue.

(*d*) On Ground Rents exceeding £1,000. As in (*c*) on first £1,000, plus 25 per cent on the residue, together with 5 per cent on the first £1,000 of the Premium and 2½ per cent on the residue.

On Assigning Building Agreements at Premium :—

One-half of the Scale for Letting Land on Building Lease together with 5 per cent on the first £1,000 of the Premium and 2½ per cent on the residue.

For Approving Plans submitted by Lessees, and inspecting buildings during progress :—

One guinea per cent up to £20,000, and half a guinea per cent thereafter on the estimated cost of each building. (Minimum fee, 3 guineas.)

V.

ESTATE AGENCIES AND COLLECTION OF RENTS OR TITHES

2½ to 5 per cent on ground rents, according to the amount of the rents and the number of collections.

7½ per cent upon the gross rental of agricultural estates.

10 per cent upon gross rental of weekly property.

5 per cent upon gross rental of other property or tithes ; the percentage, in each of the four cases enumerated, including management and collection of rents.

SOLICITORS' SCALES OF CHARGES ON SALES, PURCHASES, AND MORTGAGES, UNREGISTERED LAND

SCALE

	(1) for the 1st £1,000	(2) for the 2nd and 3rd £1,000	(3) for the 4th and each subsequent £1,000 up to £10,000	(4) for each subsequent £1,000 up to £100,000
	per £100 s. d.	per £100 s. d.	per £100 s. d.	per £100 s. d.
*Vendor's solicitor for negotiating a sale of property by private contract	20 0	20 0	10 0	5 0
Do., do., for conducting a sale of property by public auction, including the conditions of sale :— When the property is sold	20 0	10 0	5 0	2 6
† When the property is not sold, then on the reserved price ...	10 0	5 0	2 6	1 3
(N.B. — A minimum charge of £5 to be made whether a sale is effected or not) ... Do., do., for deducing title to freehold, copyhold, or leasehold property, and perusing and completing conveyance (including preparation of contract or conditions of sale, if any)	30 0	20 0	10 0	5 0
*Purchaser's solicitor for negotiating a purchase of property by private contract	20 0	20 0	10 0	5 0
Do., do., for investigating title to freehold, copyhold, or leasehold property, and preparing and completing conveyance (including perusal and completion of contract if any)	30	20 0	10 0	5 0
Mortgagor's solicitor for deducing title to freehold, copyhold, or leasehold property, perusing mortgage, and completing	30 0	20 0	10 0	5 0
Mortgagees' solicitor for negotiating loan ...	20 0	20 0	5 0	2 6
‡(Mortgagor's Solicitor for negotiating is half these fees)				

Every transaction exceeding £100,000 to be charged for as if it were £100,000.

Statutory 20 per cent increase to be added to these charges.

* These scales are not very common, usually the work of negotiating is done by the estate agent.

† The percentage on the reserve in the event of the property not selling is not very often charged, usually the Solicitor charges details for the work actually done and when the property is subsequently sold by private treaty and the same general form of contract used this latter course is nearly always followed.

‡ If the same solicitor acts for both mortgagor and mortgagee his charge for negotiating is rather less than if separate solicitors acted. The same applies not only to the negotiating fee but also the fees for deducing and investigating title when the same solicitor acts for both parties.

The fact should not be overlooked that when a legal mortgage is raised upon property the mortgagee will almost invariably require some sort of valuation of the property by a competent surveyor who will charge a fee for making his valuation and when the mortgagee is a trustee he is bound by law to require a surveyor's valuation and report when the ordinary scale of valuations is applicable.

Actually a valuation fee is not Solicitors' costs, but it is a matter which obviously must be taken into calculation when working out a mortgage and the Solicitors' costs which are payable. The usual practice is for the Solicitor acting for the mortgagee to instruct the surveyor to make the valuation and report and the Solicitor generally collects the valuation fee from the client and settles with the surveyor.

WHERE LAND IS REGISTERED

SCALE OF REMUNERATION FOR TRANSFERS ON SALE, CHARGES, SUB-CHARGES, MORTGAGES, SUB-MORTGAGES AND TRANSFERS THEREOF

Value of land or amount of charge.	Scale of Remuneration.
1. For the first £1,000 ...	15s. per £100 (with a minimum of £1 10s.)
For the second and third £1,000	10s. per £100
For the fourth and fifth £1,000	5s. per £100
For the sixth and each subsequent £1,000 up to £10,000	4s. per £100
For each subsequent £1,000 up to £100,000	2s. per £100

2. Fractions of £100 under £50 to be reckoned as £50.
   Fractions of £100 above £50 to be reckoned as £100.
3. Every transaction exceeding £100,000 to be charged for as if it were £100,000.

Statutory 20 per cent increase to be added to these charges.

Note.—Mortgagors and Mortgagees solicitors for negotiating a loan are the same whether the land is registered or not.

SCALE OF CHARGES AS TO LEASES, OR AGREEMENTS FOR LEASES, AT RACK RENT (other than a Mining Lease, or a Lease for Building Purposes, or Agreement for the same).

Lessor's solicitors for preparing, settling, and completing lease and counterpart :—

Where the rent does not exceed £100	£7 10s. per cent on the rental but not less in any case than £5.
Where the rent exceeds £100 and does not exceed £500	£7 10s. in respect of the first £100 of rent, and £2 10s. in respect of each subsequent £100 of rent.
Where the rent exceeds £500	£7 10s. in respect of the first £100 of rent, £2 10s. in respect of each £100 of rent up to £500, and £1 in respect of every subsequent £100.
Lessee's solicitor for perusing draft and completing ...	One-half of the amount payable to the Lessor's solicitor.

SCALE OF CHARGES AS TO CONVEYANCES IN FEE, OR FOR ANY OTHER FREEHOLD ESTATE RESERVING RENT, OR BUILDING LEASES RESERVING RENT, OR OTHER LONG LEASES NOT AT RACK RENT (EXCEPT MINING LEASES), OR AGREEMENTS FOR THE SAME RESPECTIVELY.

Vendor's or Lessor's solicitor for preparing, settling, and completing conveyance and duplicate, or lease and counterpart :—

Amount of Annual Rent	Amount of Remuneration
Where it does not exceed £5	£5.
Where it exceeds £5, and not exceed £50	The same payment as on a rent of £5, and also 20 per cent on the excess beyond £5
Where it exceeds £50, but not exceed £150	The same payment as on a rent of £50, and 10 per cent on the excess beyond £50.
Where it exceeds £150 ...	The same payment as on a rent of £150, and 5 per cent on the excess beyond £150.

Where a varying rent is payable, the amount of annual rent is to mean the largest amount of annual rent.

Purchaser's or Lessee's solicitor for perusing draft and completing—one-half of the amount payable to the Vendor's or Lessor's solicitor.

Statutory 20 per cent increase to be added to these charges.

Note.—(1) It is the almost universal practice that the Tenant pays the Landlord's Solicitors charges on preparation of a lease as well as his own. It is as well to confirm from the Solicitor acting that this is the practice in the particular district being dealt with.

(2) Conveyances in fee or any other freehold estate reserving a rent has particular application to Chief Rents in Lancashire and the North of England.

STAMP DUTIES

AGREEMENTS FOR LEASE, ETC.

If the term is definite and does not exceed 35 years, or is indefinite, or for a premium for a lease :—

Yearly Rent Exceeding	Yearly Rent Not Exceeding	Stamp Duty
£	£	£ s. d.
—	5	1 0
5	10	2 0
10	15	3 0
15	20	4 0
20	25	5 0
25	50	10 0
50	75	15 0
75	100	1 0 0
100 (for £50, or fractional part of £50)		10 0

If the term being definite exceeds 35 years but does not exceed 100 years :—

Yearly Rent Exceeding	Yearly Rent Not Exceeding	Stamp Duty
£	£	£ s. d.
—	5	6 0
5	10	12 0
10	15	18 0
15	20	1 4 0
20	25	1 10 0
25	50	3 0 0

Yearly Rent Exceeding	Yearly Rent Not Exceeding	Stamp Duty
£	£	£ s. d.
50	75	4 10 0
75	100	6 0 0
100 (for £50 or fractional part of £50)		3 0 0

Term exceeding 100 years :—

Yearly Rent Exceeding	Yearly Rent Not exceeding	Stamp Duty
£	£	£ s. d.
—	5	12 0
5	10	1 4 0
10	15	1 16 0
15	20	2 8 0
20	25	3 0 0
25	50	6 0 0
50	75	9 0 0
75	100	12 0 0
100 (for £50, or fractional part of £50)		6 0 0

Appraisement or Valuation.

Of any property, or of any interest therein, or of the annual value thereof, or of any dilapidations, or of any repairs wanted or of the materials and labour used or to be used in any building, or of any artificers' work whatsoever :—

Not Exceeding,	Stamp Duty
5	£ s. d.
5	3
10	6
20	1 0
30	1 6
40	2 0
50	2 6
100	5 0
200	10 0
500	15 0
Exceeding £500	1 0 0

EXEMPTIONS

1. Appraisement or valuation made for, and for the information of one party only, and not being in any manner obligatory as between parties either by agreement or operation of law.
2. Appraisement or valuation made in pursuance of the order of any Court of Admiralty, or of any Court of Appeal from a judgment of any Court of Admiralty.
3. Appraisement of valuation of property of a deceased person made for the information of an executor or other person required to deliver in England or Ireland, an affidavit, or to record in any commissary court in Scotland an inventory of the estate of such deceased person.
4. Appraisement of valuation of any property made for the purpose of ascertaining the legacy or succession duty payable in respect thereof.

Every Appraiser shall, within 14 days after the making of an appraisement or valuation, write out the same in words and figures showing the full amount thereof, upon duly stamped material under the penalty of £50. Any person who receives from an appraiser, or pays for the making of any appraisement or valuation, unless written out and stamped as aforesaid, shall forfeit £20.

CONVEYANCE OR TRANSFER

On sale of any property (except stocks and shares).

Purchase Money Exceeding	Purchase Money Not Exceeding	Stamp Duty
£	£	s. d.
—	5	1 0
5	10	2 0
10	15	3 0
15	20	4 0
20	25	5 0
For every additional £25 up to £300		5 0
If exceeding £300, then for every £50		10 0
Of any kind not otherwise charged		10 0

On a sale of land where the consideration does not exceed £500 on a single transaction the stamp duty is half full rate, i.e., on £500, £2 10s. and not £5.

MORTGAGE BOND

Not exceeding	Stamp Duty
£	s. d.
10	3
25	8
50	1 3
100	2 6
150	3 9
200	5 0
250	6 3
300	7 6
Exceeding £300, for every £100 and fractional part of £100	2 6
Transfer of Mortgage (except marketable securities) for every £100	6
Reconveyance, Release, etc., per £100	6
Collateral, or auxiliary, or additional, or substituted security (other than an equitable mortgage), when the principal security is duly stamped ; for every £100, or fraction of £100, 6d. up to a maximum of ...	10 0

NOTE ON LAND REGISTRATION IN ENGLAND

The effect of registration with an absolute or good leasehold title is to give the owner a state guaranteed title. In addition registration possesses numerous advantages particularly to a person developing a building estate. The preliminary cost of putting the whole estate on the register and the quite moderate fee involved is amply repaid by the future saving in cost on the occasion of each transfer or mortgage of a plot. A very great saving of time is also effected when plots are sold, for it is far easier as well as cheaper to deal with numerous sales when the land is registered and it is correspondingly quicker to effect mortgages and to carry through mortgages for other persons. The saving of time and trouble is particularly advantageous when, as so often is the case, the estate being developed is on the border of an urban area and has been carved out of an old agricultural property, where the title is frequently long and troublesome and purchasers of small individual plots have much difficulty in identifying their plot which is, for instance, on a new road which does not appear on any plan on any of the earlier title deeds. The saving in cost and time is a very definite advantage to a purchaser as well as to the owner.

The only compulsory areas for registration are the Counties of London and Middlesex, and the County Borough of Croydon, Hastings, Eastbourne and their immediate environs in Sussex, but land anywhere in England and Wales may be put upon the register in the same way and at the same cost. Any enquiries as to registration may be made at the Enquiry Office at the Land Registry, Lincoln's Inn Fields which is accustomed to dealing with enquiries from the layman as well as from the lawyer.

THE MIDDLESEX AND YORKSHIRE DEEDS REGISTRIES

These are not to be confused with the Land Registry. They are only registries of Deeds. The fees involved are trifling and the formalities should be left to the Solicitor.

COMPARATIVE TABLES SHOWING RESULTS OF CONVEYANCING BY PRIVATE DEEDS AND STATE REGISTRATION

The following Table (reprinted by kind permission of " The National Builder ") gives a comparison of the saving of charges effected by registering a building estate :—

At all values there is a substantial saving to vendors, purchasers and mortgagors through the registration of land. The following table illustrates at six representative values the saving to the first registered Proprietor when he comes to sell or mortgage :—

Value of Land or Amount of Mortgage	£100	£500	£1,000	£5,000	£50,000	£100,000
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Gross minimum saving to vendor of registered land	4 13 4	5 0 0	10 0 0	30 0 0	130 0 0	172 10 0
Additional cost of first registration to First Registered Proprietor*	1 11 0	2 1 0	3 6 0	11 2 0	36 2 0	61 2 0
Net minimum saving to First Registered Proprietor when he sells	3 2 4	2 19 0	6 14 0	18 18 0	93 18 0	111 8 0
Saving to First Registered Proprietor if he mortgage, after Registration. (Same Solicitor acting for mortgagor and mortgagee)	6 16 0	6 10 0	12 15 0	32 10 0	105 0 0	133 2 6

*The additional cost includes the Land Registry fee and solicitors' charges for conducting the first registration.

LAND REGISTRATION, ENGLAND

Fees payable to Registrar

First Registration ... ... I. On an application for first registration (whether with absolute good leasehold or possessory title)—(other than registrations mentioned under II or III, below)—

Scale No. 1.

Value of Land	Fee
Not exceeding £750... ...	1s. for every £25 or part of £25, with a minimum fee of 10s.
Exceeding £750, but not exceeding £1,500	£1 10s. for the first £750 and 3s. for every £50 or part of £50 over £750.
Exceeding £1,500 but not exceeding £2,000	£3 15s. for the first £1,500 and 2s. 6d. for every £50 or part of £50 over £1,500.
Exceeding £2,000, but not exceeding £3,000	£5 for the first £2,000, and 2s. for every £50 or part of £50 over £2,000.
Exceeding £3,000 but not exceeding £10,000	£7 for the first £3,000 and 1s. for every £50 or part of £50 over £3,000.
Exceeding £10,000 but not exceeding £100,000	£14 for the first £10,000 and 1s. for every £100 or part of £100 over £10,000.
Exceeding £100,000	As for £100,000.

II. On an application for first registration (whether with absolute good leasehold or possessory title).

(1) By an original lessee or his personal representative on the grant of a lease other than a lease at a rack rent or a mining lease.

(2) On a grant of freehold land in consideration of a rent.

Scale No. 2.

Largest Amount of Annual Rent	Fee
Not exceeding £10	10s.
Exceeding £10 and not exceeding £50	10s. for the first £10 and 2s. every £5 or part of £5 over £10.
Exceeding £50 and not exceeding £150	£1 6s. for the first £50 and 1s. for every £5 or part of £5 over £50.
Exceeding £150	£2 6s. for the first £150 and 6d. for every £5 or part of £5 over £150 up to a maximum fee of £59.

together with a fee under Scale No. 1 above on any money payment therein provided that a maximum fee of £59 on the rent and money payment is not exceeded.

III. On an application for first registration (whether with absolute good leasehold or possessory title) on the grant of a lease at a rack rent :—

Scale No. 3.

Largest Amount of Annual Rent	Fee
Not exceeding £100... ...	3s. for every £20 or part of £20, with a minimum fee of 10s.
Exceeding £100 and not exceeding £500	15s. for the first £100 and 1s. for every £20 or part of £20 over £100.
Exceeding £500	£1 15s. for the first £500 and 1s. for every £50 or part of £50 over £500 up to a maximum fee of £59.

Dealings **IV. On application for registration of a :—**

(1) Transfer on sale.

(2) Charge or sub-charge

Scale No. 4.

Value of Land or Amount of Charge or Mortgage	Fee
Not exceeding £750... ...	1s. for every £25 or part of £25.
Exceeding £750, but not exceeding £1,500	£1 10s. for the first £750 and 3s. for every £50 or part of £50 over £750.
Exceeding £1,500, but not exceeding £10,000	£3 15s. for the first £1,500 and 2s. 6d. for every £50 or part of £50 over £1,500.
Exceeding £10,000 but not exceeding £50,000	£25 for the first £10,000 and 2s. for every £100 or part of £100 over £10,000.
Exceeding £50,000 but not exceeding £100,000	£65 for the first £50,000 and 10s. for every £1,000 or part of £1,000 over £50,000.
Exceeding £100,000 ...	As for £100,000.

Note.—

In the event of a Transfer and Charge of the property comprised in the Transfer being presented simultaneously at the Land Registry the fee payable is a full fee on the Transfer and a moiety of the fee payable on the Charge.

In addition to the fees set out in the above scales the Registrar is empowered to charge small Nominal fees for lodging cautions, priority notices, rectification of registers, etc.

RESTRICTIVE COVENANTS AFFECTING EITHER FREEHOLD OR LEASEHOLD

Where there is a restrictive covenant on property which seriously affects its development for present day purposes, provided that the removal of the covenant is not likely seriously to injure the person or his successors for whose benefit the covenant was given originally or in some cases adjoining owners, it is generally possible to have the covenant removed or modified by one of several processes. The actual steps for removing the covenants are technical and Solicitor's advice would have to be taken, but as a general rule it may be assumed that ancient covenants affecting property provided their removal damages nobody may be got rid of by some method.

OLD MANORIAL DOCUMENTS

It frequently happens that a purchaser of a country estate may receive among the title deeds which he is handed on completion a number of old manorial documents such as Court Rolls and the like. These documents are frequently of historical and antiquarian importance and value. It should be noted that all such manorial documents are in the charge and superintendence of the Master of the Rolls and the owner of them is bound to preserve them carefully. If the owner wishes to be relieved from the burden of keeping them he should communicate with the Master of the Rolls, Public Record Office, Chancery Lane, London, E.C.4, who will make arrangements then for their deposit in any public library, museum, historical or antiquarian society. These provisions for the preservation of old manorial documents are compulsory by law, but it is always open to an owner of land to deposit with a public library or learned society any old title deeds which are now of no legal value but possess some historic interest, and this is a course which is to be recommended, particularly when an estate has been developed and the building owner is not likely to remain in permanent possession of the land with which he is dealing.

APPEALS, ETC.

By a Barrister-at-Law

The purpose of this article is to state compendiously, in regard to the most important matters with which an architect is concerned, what right of recourse his client has to superior authority, where it is desired to question some requirement which is sought to be imposed by a local authority or similar body.

There are certain cautions to be inserted here about the law. The architect should no more set out to be a lawyer than a barrister or solicitor should set out to be an architect. Much mischief has been done (and much money of clients has been wasted) because architects and even builders have too readily believed that they knew the law affecting the work they had to carry out for clients, or have too lightly assumed that local authorities and similar bodies had legal warrant for wanting this or that done. Where the law is involved, the architect needs to steer a middle course. Obviously he should not ask his client to seek legal advice wantonly, or for the sake of scoring a point against local government officials with whom the architect may have some difference of opinion. On the other hand, he owes a duty to his client not to acquiesce, without further inquiry, in the imposition of unusual or arbitrary requirements, and he also owes a duty to his client not to attempt to deal, himself, with matters outside his professional competence.

DEFINITIONS OF "APPEAL"

The second note of caution to be sounded at this stage is this : the phrase "Appeals, etc." is used in the heading to this article because no other convenient short phrase can readily be found. It must be emphasised, however, that many of the rights of recourse to some superior authority which the law provides are not described as "appeals" in Acts of Parliament. This may seem a minor verbal matter : e.g., whether a statute says that there shall be an appeal to a Court of Summary Jurisdiction or says that a difference of opinion may be determined by a Court of Summary Jurisdiction, but the course of the proceedings may differ, according as Parliament has used the technical word "appeal" or not.

Again, in many, probably most, of the matters with which an architect is concerned which may result in a difference of opinion with local authorities or their officials, the right of recourse (to use a neutral term) is to the ordinary courts, sometimes Quarter Sessions, but most often a Court of Summary Jurisdiction. As stated above, this right of recourse may, or may not, be a technical "appeal." Other rights of recourse are to a Minister of the Crown, such as the Minister of Transport, the Minister of Town and Country Planning, or the Minister of Health. It does not seem that Parliament has followed any consistent plan in deciding which matters should go to Ministers and which to the courts : certainly there is at present no consistency upon the point whether recourse shall be to a Court of Summary Jurisdiction or to Quarter Sessions.

Thirdly, a large class of matters may go before the Minister of Health for a decision, upon an agreed reference by the local authority of the one part and the building owner of the other. This procedure is not called an "appeal" and, although put on a statutory footing in 1936 and before that used voluntarily to an increasing extent, is not as widely known as it should be. It should also be noted that, in this matter of appeals (or recourse to a higher against a lower authority), London stands, as in almost all matters affecting building, outside the ordinary system. There is a Tribunal of Appeal under the London Building Acts, which has strictly limited jurisdiction, much

more limited than is frequently supposed. There are cases in which there is a right of appeal from a metropolitan borough council to the London County Council—a procedure for which (namely, an appeal from one elected body to another) there is no parallel in provincial law.
Lastly, the District Surveyors, and the London County Council itself, have a much larger number of powers exercisable at their discretion, without any right of appeal or recourse to any superior authority, than is possessed by provincial authorities. Speaking broadly (and not quite accurately), it can be said that, outside London, no local government official exercises any jurisdiction of his own in building matters, such as is exercised by the District Surveyors under the London Building Acts ; in the provinces, the officials of town councils, county councils, or district councils (however highly qualified and highly paid) act, and can act only, on the instructions of the elected local authority, whilst the number of cases in which even the largest local authorities have a discretion (unfettered by a legal right of appeal or of recourse to some superior authority) is extremely small. It is, therefore, always worth while for the architect, who finds that some demand is being made by a local authority or a local official which strikes him as unreasonable, to go into the matter and make sure whether there is a right of recourse to the courts, to a Minister, or to some other superior authority.

NON-UNIFORMITY IN THE LAW

In connexion with appeals, as with almost every other legal topic mentioned in this work, the reader must keep it firmly in his mind that the law is not the same in all districts. Prominent architects have constantly complained in books and lectures of an alleged divergency between the building byelaws of different local authorities ; in fact, leaving London on one side, the building byelaws of local authorities have always, since 1877, been based upon the successive model series, and such divergencies as have existed have (where not due to some climatic or other local circumstance) been almost wholly due to their having been enacted at different dates, and thus based upon different editions of the models.
At the present day there are no serious divergencies in building byelaws between one district and another, and there have never been such divergencies as exist in the statute law. The Town and Country Planning Acts, 1932–1944, and the Restriction of Ribbon Development Acts, 1935–1943, present a uniform pattern throughout the country. It might be expected that the law of public health would be uniform, but it is widely (one might almost say wildly) different from place to place. The Public Health (London) Act, 1936, deals with identical topics in terms which are not the same as those of the Public Health Act, 1936, applying elsewhere. Earlier Public Health Acts of 1875, 1890, 1907 and 1925 still survive (in part) in the provinces but do not apply in London.
Most large towns, and many small ones, have special Acts of Parliament adding to the Public Health Acts, and imposing restrictions of various sorts upon building and development. Some half dozen provincial towns have local Acts under which building and development are (as under the London Building Acts) controlled in a manner divergent from the ordinary provincial law. These Acts, general and local, present a combined picture of very great confusion, and, although most of them provide in one way or another for *appeals* from the requirements imposed by local authorities, in the wide sense in which the word " appeal " is used above, there is, unfortunately, no consistency as to what the appellate tribunal is to be. It is, therefore, impossible, in these notes or within any reasonable compass, to give the reader a complete account of the appeals available to him or to his client. An attempt will be made to set out the most important of them, in the order in which they will come into the field of vision as development proceeds.
The question, what provisions of the Public Health Acts or other general Acts are in force, and what overlapping or supplementary provisions there may be in local Acts of Parliament, can only be solved by inquiry on the spot. Local Act provisions similar to provisions which occur in building byelaws are by statute required to be printed and bound with the local authority's byelaws. Some statutory provisions or requirements imposed thereunder have to be entered in the register of local land charges, kept by the clerk of the local authority. Others, particularly the " adoption " by the local authority of provisions of general Acts which can be put in force by adoption, or the putting into force by the order of some Minister of provisions which require such an order, are not recorded in any public register : information can be obtained from the appropriate Government Department in London, usually the Ministry of Health, but—inasmuch as there are other things locally noted—it is probably best at the outset of any major development to call at the office of the clerk to the local authority and collect full information. The architect will then be in a position to consider what are the provisions against which, and under which, he may need to lodge some appeal, or make some application, to a superior authority as the development proceeds.

TOWN AND COUNTRY PLANNING

I. Where a scheme is operative

An operative planning scheme will be found to contain its own provisions for appeal ; it may contain clauses expressly mentioning appeals, and it will certainly contain clauses saying that this or that shall be an offence for which a fine may be imposed by a Court of Summary Jurisdiction. Upon such provisions it is always open to the person affected to contend before the magistrates that he has not committed the offence. Further, section 13 of the Town and Country Planning Act, 1932, empowers a planning authority to pull down buildings, etc., which do not conform to an operative scheme, including those existing previously. This power is subject to *appeal* to a Court of Summary Jurisdiction. Most operative schemes probably include also a provision for controlling the external design and appearance of buildings ; where a scheme did so, the Acts earlier than 1944 required that it should give an *appeal* either to a Court of Summary Jurisdiction or to a specially constituted tribunal, but by Section 44 of the Town and Country Planning Act, 1944, schemes made after that date can provide that an *appeal* in this, as in any other matter, shall go to the Minister of Town and Country Planning.

II. Interim development

Interim development, at the stage so far reached, is much the most important aspect of town and country planning for the ordinary owner and developer of property, since the Town and Country Planning (Interim Development) Act, 1943, has applied the system to all land for which there is not an operative scheme. Usually, therefore, it will be desired before any development is undertaken to apply for the permission of the (local) interim development authority. It is well to remember that interim development permission can be refused (or granted subject to conditions), for virtually any reason (even some reason overlapping specific provisions of some other Act) but, generally, refusal is on account of the nature of the building or other development, its appearance, its intended use, or the intended lay out. If that permission is refused, or is granted subject to conditions, the applicant has a right of *appeal* to the Minister of Town and Country Planning.

THE STREET

I. New Streets

The expression " new street " here means a street at the stage of its coming into existence, by marking out a strip of ground (sometimes along an existing path) where no street existed previously. Apart from London (where this aspect is not likely to affect many private developers), and from the very few provincial towns where local Acts prevail, the width of new streets, and such construction as is done at the preliminary stage, is governed, if at all, by byelaws of the local authority. Such byelaws will be found in most urban areas ; less often in rural areas. There is *no* right of " appeal " against their requirements, but they had all been brought up to date before the war, and will not be found to cause difficulty.

In addition, many local authorities have by adopting Section 31 of the Public Health Act, 1925, acquired power to insist that a person who lays out a new street shall make it wider than is required by the local authority's own byelaws. There is a right of *appeal* to Quarter Sessions, if the local authority does insist on this, and they must pay *compensation* if they insist on more than twenty feet above the byelaw width.

In London, the corresponding provisions will be found in Part II of the London Building Act, 1930. In certain cases, this gives a right of appeal to the Tribunal of Appeal.

II. Existing (unadopted) Streets

After a new street has been laid out, and constructed at its preliminary stage, a long time may elapse before it is made up and taken over or " adopted " by the local authority. There are hundreds of streets in country towns which have remained unadopted for fifty years or more. Repeating the warning that the London law is different from that elsewhere, and that this is a matter which is fairly often affected by local Acts, there are, in regard to adoption of existing streets, two distinct codes of law, with distinct requirements, and methods of appeal, and in a borough or urban district the first thing to find out is under which code the local authority operates. In a rural district they have no choice ; the county council (not the rural district council) are responsible for " private street works " and must proceed under the Private Street Works Act, 1892. In a borough or urban district the council may proceed under that Act or under Section 150 of the Public Health Act, 1875. It is at their option which code they will use, but, if they have once decided upon that of 1892, they can not go back on the decision and use the code of 1875. As stated above, the procedures are quite different.

Under the Act of 1875, a person aggrieved by the work which the local authority demands before it will adopt the street has a right of *appeal* to the Minister of Health. Under the Act of 1892, such a person's *appeal* is to a Court of Summary Jurisdiction.

RESTRICTION OF RIBBON DEVELOPMENT

Fuller information about the Restriction of Ribbon Development Act, 1935, will be found earlier in this work. The Act applies in London as well as in the provinces. Authorities for the purposes of the Act are county councils, town councils, or urban district councils, by whom the functions of road maintenance and repair are exercised. In regard to trunk roads also, these authorities are responsible for administering the Restriction of Ribbon Development Act, even though trunk roads are maintained by the Government.

For purposes of the Act the word " building " includes any part of a building ; most structures and erections are also covered. Control under the Act applies also to certain changes in the use of a building, to the extension of a building, to the re-erection of a building, and to permanent excavations and other works. For all these consent is required from the responsible authority, if the building or work is within a certain distance of the centre of the road. Consent is also required for the opening of any means of access to the road. Where consent is refused or granted subject to conditions, there is a right of *appeal* to the Minister of Transport. Unless otherwise agreed consent is deemed to have been given unconditionally if the responsible authority have not notified their decision within two months or, in the case of a trunk road, three months. An owner who is affected by the restrictions under the Act is entitled to *compensation* at the time when he can prove that his property is injuriously affected. It may be, therefore, that circumstances arising between the imposing of the restriction and the time when the owner is ready to develop will be found to deprive him of compensation.

IMPROVEMENT LINES

Local authorities outside London have power under the Public Health Act, 1925, to prescribe an improvement line in relation to any street repairable by them. This means the line to which a street is sooner or later to be widened. Where an improvement line has been prescribed the authority's consent is necessary before a building can be erected in front of the line. There is a right of *appeal* to Quarter Sessions, both against the prescribing of a line and against a refusal of consent to build. There is provision in the Act for *compensating* persons whose property is injuriously affected. There is no London provision precisely corresponding.

BUILDING LINES

A building line must be distinguished from the improvement line : the two may coincide in practice but a building line is a line in front of which buildings are not to be erected, and, therefore, may be further back than an improvement line as above defined. They are often confused perhaps (partly) because building lines outside London are prescribed under the Roads Improvement Act, 1925, i.e., the language is confusing. This Act enables any highway authority to prescribe a building line in any highway maintainable by them. Where such a building line is in force it is unlawful to build in front of it without the consent of the authority who prescribed it. Consent if given may be subject to conditions.

There is *no right of appeal* to any superior authority, against the prescribing of a line or the refusal of consent where a line has been prescribed. There is provision for *compensation* to owners whose property is injuriously affected by the prescribing of the line, but *not* for compensation to persons adversely affected by refusal of consent to building in front of the line.

The building line as defined above is called by that name in the Act of Parliament ; it is, as already stated, prescribed by the local authority. The name " building line " is sometimes applied also to a line which, without being prescribed by any authority, comes into existence where the Public Health (Buildings in Streets) Act, 1888, is in force. The Act is not in force in London nor usually in rural districts, but is in force in all provincial boroughs and urban districts. The Act makes it unlawful to erect or bring forward without the consent of the local authority any building or part of a building, beyond the front main wall of the building on either side in the same street. The Act is extremely technical, almost every operative word having been the subject of judicial decision. In the event of dispute with the local authority, the builder or building owner should obtain legal advice as soon as possible. A person from whom consent is withheld has a right of *appeal* to Quarter Sessions but, if he does not appeal or if his appeal to Quarter Sessions is unsuccessful, he has *no* right of compensation.

In London, there are special provisions in Part III of the London Building Act, 1930. The most important of these is that which empowers the Superintending Architect to define by his certificate the "general line" of building in any street. There is a right of *appeal* to the Tribunal of Appeal against his certificate, and in certain cases a right to *compensation*. After the line has been defined, the L.C.C.'s consent is required to building in front of it, and there is *no* right of appeal against refusal of this consent.

SPACE ABOUT BUILDINGS

Having settled the limits of the street or road on which a building plot abuts, the architect has to determine where his building can be placed upon the plot. In addition to the restrictions under various Acts which have already been dealt with, there are requirements imposed under the Public Health Acts (outside London) for the purpose of ventilation and securing the free circulation of air about buildings. Broadly, it can be said that in all provincial areas there must be, in front and at the rear of a new building, a minimum of open space. The actual amount is stipulated in byelaws made by the local authority. In front the open space required by byelaws is commonly measured from the opposite side of the street, so that in practice no extra obligation is imposed. The open space in the rear is, again, no more than is reasonably necessary to secure ventilation. The requirements are *minima* imposed by law : there is, that is to say, *no appeal* against their requirements in a particular case but of course, if there is a real dispute as to the measurement of the open space, this can be determined either in legal proceedings for the purpose or in the other methods which will be enumerated below in connexion with byelaws generally.

In London, rather similar requirements are contained in Part V of the London Building Act, 1930. Some of these are positive enactments ; some are at the discretion of the L.C.C. ; some at the discretion of the Superintending Architect or District Surveyor. Most of the discretionary requirements carry a right of *appeal* to the Tribunal of Appeal.

ACCESS TO BUILDINGS

Where plans of a new house are deposited with a local authority outside London the local authority must under Section 55 of the Public Health Act, 1936, insist that there shall be satisfactory access from a public way for the removal of refuse and other matters. What is satisfactory is for the local authority to consider first and, as with practically all discretionary requirements in the field of public health, there is an *appeal* to the ordinary courts—in this case a Court of Summary Jurisdiction if the builder or building owner is aggrieved by the local authority's idea of what is satisfactory. Note, however, that neither the local authority nor the Court can dispense with access altogether. Note, also, that the section does not apply except to a house. There is no precisely corresponding requirement in London.

WORK ON SITE

This falls to be considered under the main headings of sewers and foundations. The local authority may reject the plan of a building submitted to them if it is proposed to erect it over a sewer or drain, or if the proposed building has not satisfactory provision for sewerage and drainage. There is a right of appeal to a Court of Summary Jurisdiction against the rejection of plans on these grounds. The actual drainage of the building must be carried out in accordance with the local authority's byelaws. As stated above, in connexion with other byelaws, these impose minimum requirements, and there is *no appeal* against their provisions, though it is open to the builder or building owner to dispute the application of the byelaws, and to insist upon taking a decision of the courts upon any question of fact.

Where it is proposed to erect a building on ground impregnated with offensive matter, the local authority must reject the plan unless they are satisfied that the offensive matter has been removed or become innocuous. There is a right of *appeal* to a Court of Summary Jurisdiction.

The actual foundations on which the building is erected must be in accordance with the local authority's byelaws which (outside London) will be found substantially the same in every district. As before, there is *no appeal* against their requirements but the decision of the courts can be taken upon disputed questions of fact.

In London, the corresponding provisions will be found chiefly in byelaws made by the L.C.C. under the London Building Acts Amendment Act, 1935, and the Public Health (London) Act, 1936. What is said about London, under the heading next below, can be taken as substantially applicable.

THE BUILDING : MODE OF CONSTRUCTION

The chief parts which go to make up the building itself (as distinct from fittings) are the walls, chimneys, roof, and floors, with the staircase where the building comprises more than one storey. The construction of all these is regulated, in some detail, by the byelaws of all local authorities outside London, and what is said above about byelaws applies. It is not necessary to go more fully into this matter for the present purpose.

In London, Part III of the London Building Acts Amendment Act, 1939, coupled with byelaws made by the L.C.C. under the London Building Acts Amendment Act, 1935, produce something like the same result, but there are many discretionary powers, vested in the L.C.C. and the District Surveyors, which have no parallel outside London. Many of these discretionary powers, but not all, are subject to a right of *appeal* to the Tribunal of Appeal.

SHORT LIVED MATERIALS

Section 53 of the Public Health Act, 1936, empowers local authorities outside London to reject the plans of a building, or when they pass the plans to impose restrictions, going beyond those in the Public Health Acts or their own byelaws, if it is proposed to erect the building of any materials specified in their byelaws as being liable (in the absence of reasonable care) to rapid deterioration or otherwise unsuitable for use in the construction of permanent buildings. If they do so, *the first thing is to verify* that the proposed materials are in reality specified in the council's byelaw ; if they are not, the council cannot use this section. It is also important to notice that the Public Health Acts (outside London) do not draw any distinction between temporary and permanent buildings as such. (It is sometimes supposed that the law is less drastic in regard to temporary buildings than in regard to permanent buildings, but this is not so, and a building owner or architect has nothing to gain by claiming that his building will be only temporary. On the contrary, if the ground upon which he regards it as temporary is that its walls are of such materials that they will not be likely to last for more than some quite limited period, this brings into play the extra restriction under Section 53 of the Act of 1936.) If a local authority reject the plans of a building or impose restrictions, such as a time limit, by reason of the fact that it is to be constructed of short lived materials, there is a right of *appeal* to a Court of Summary Jurisdiction. There is no precisely corresponding provision in London, but Part IV of the London Building Acts Amendment Act, 1939, gives to the L.C.C. and to Metropolitan Borough Councils certain powers in regard to " special and temporary " buildings, as defined in that Act. These powers are *not* subject to *appeal*.

FITTINGS OF BUILDINGS

The most important internal fittings are those for the removal of foul matters and the supply of water. By the Public Health Act, 1936, applying everywhere outside London, there must ordinarily be a water closet or earth closet and a sink, but the requirements of the local authority in these matters can be made the subject of *appeal* to a Court of Summary Jurisdiction. The actual work of installing this sort of apparatus is covered, in some detail, by the byelaws of all local authorities outside London and what has been said above about byelaws applies. As to water supply, see below.

DRAINS

It has been mentioned above that a local authority outside London has by the Public Health Act, 1936, power to insist on the drainage of buildings subject to an *appeal* to a Court of Summary Jurisdiction. The actual mode of laying the drains and the materials to be used for them are covered by the local authority's byelaws, and what is said above about byelaws will apply.

In London, what is said above under the heading " Work on Site " substantially applies here also.

WATER SUPPLY

The Public Health Act, 1936, as amended by the Water Act, 1945, requires the local authority outside London to reject the plans of a dwelling house unless satisfied that it will have a water supply, which must ordinarily be obtained from a public water undertaking. If there is no public supply available, a supply must be obtained from other sources, to the satisfaction of the local authority. The local authority is authorised by the Acts to give the owner written notice prohibiting occupation of the house, until they have granted a certificate that the water supply is satisfactory. The refusal of this certificate can, however, be made the subject of *appeal* to a Court of Summary Jurisdiction. The kind of fittings to be used, and the mode of installing them, are usually

governed by byelaws of the local authority or water undertakers. These byelaws (outside the area of the M.W.B.) are normally based upon model byelaws issued from the Ministry of Health, and contain (essentially) similar requirements. As with other byelaws, there is *no* right of appeal against compliance with them in a particular case.

The Metropolitan Water Board, whose area extends beyond the County of London, have extensive and peculiar powers, both in the form of direct provisions in their special Acts of Parliament and in the form of byelaws not authorised elsewhere, but—speaking broadly—the result is similar to that just described as existing elsewhere.

BYELAWS—ENFORCEMENT AND APPEALS

The main feature, from the point of view of the present article, which distinguishes byelaws from other forms of legal enactment is that they contain only minimum provisions ; that—apart from certain London byelaws—their enforcement does not depend upon the discretion of the local authority (that is to say, the local authority are bound to enforce and, if they do not, any person aggrieved can take legal proceedings for the purpose) and that there is, accordingly, no room for an appeal against the application of the byelaw in individual cases.

On the other hand, no byelaw made by a local authority outside London (upon subjects within the scope of this work) can be put into force until it has been *confirmed* by the Minister of Health, and the Minister is forbidden by Act of Parliament to confirm until the making of the byelaw has been advertised in the district, and it has been open to public inspection for at least one month. This opportunity for public inspection, and for making objections to byelaws before they come into force, although technically *not* an " appeal," is parallel to the rights of appeal which are given in some other matters, e.g., the fixing of improvement lines, and should not be overlooked by practising architects. Once the byelaw has been confirmed and has come into force, the local authority have (as above stated) a duty to enforce it, but *disputes* may arise on interpretation, or on its application to particular facts. These disputes may be *settled in one of three ways*. The builder or building owner may go ahead with the work, and let the local authority prosecute him, when he has the right of defending himself by evidence before a Court of Summary Jurisdiction. Alternatively, he may under Section 64 of the Public Health Act, 1936, *apply to a Court of Summary Jurisdiction* before substantially beginning work, to decide any question upon a byelaw which is in dispute between him and the local authority. (The local authority will, of course, have a right to be heard by the Court before a decision is reached.) Thirdly, the builder or building owner on the one hand, and the local authority on the other hand, may under Section 67 of the Public Health Act, 1936, *agree to submit a joint statement of facts* to the Minister of Health, for a decision by him upon the application of the byelaw. This method is likely to be particularly useful in those cases which, if heard before the magistrates, would involve the taking of costly expert evidence. It is, for instance, frequently found that local byelaws prescribe some standard, in a technical matter such as steel framed construction, without giving details to show how that standard is to be attained. Many hours and perhaps days would be consumed, if a dispute about the technical details of steel structures had to be thrashed out in open court by the examination of witnesses and cross-examination.

If advantage is taken of the provision made by Section 67 of the Public Health Act, 1936, for submitting such a question to the Minister, the drawings of the steel work can be sent to him, with notes by the professional advisers of the building owner and of the local authority, and the whole thing can, without legal expenses, be decided upon scrutiny of the drawings by the Minister's advisers. What is said in this part of this note is applicable to all building byelaws outside London. Further, the Minister of Health has power, by Section 69 of the Public Health Act, 1936, to *revoke* any building byelaw which he is satisfied is, or is likely to be, an unreasonable impediment to building. This power does *not* apply to London byelaws or (of course) to provisions in any Act of Parliament.

ALUMINIUM

ITS ARCHITECTURAL USES

By Dr. E. G. WEST

Measured in terms of volume, aluminium ranks fourth in the scale of commercial metals, only iron, copper and zinc being more widely used. Many of the rocks composing the earth's surface have a high aluminium content, mainly in the form of silicates. No economic means of extracting aluminium from its compounds was discovered until 1886, when Charles Martin Hall and Paul Louis Heroult, working independently, discovered an electrolytic process which made the commercialization of the metal possible. This process is still the basic means of producing aluminium, and is known as the Hall-Heroult process. Possibly the first architectural use of the metal in England was for casting the statue of Eros (1893) in Piccadilly Circus.

Aluminium and its alloys are applied to a wide field of architectural uses. Suitable alloys are available for all forms of metal working—forgings, castings, sheet and plate, extruded sections, and rolled and drawn sections.

Aluminium is by far the lightest metal normally used in architecture, having a specific gravity of 2.71. This factor is of great importance in reducing transport costs, and makes for ease of handling and erection. Advantage has been taken of the lightness of the strong alloys to reduce dead load on bridges, and in statuary, etc. Forged aluminium is also used for casement stays, door furniture and fasteners.

NOMINAL COMPOSITION OF ALUMINIUM ALLOYS
USED FOR ARCHITECTURAL PURPOSES

PERCENTAGES OF ALLOYING CONSTITUENTS—AL. REMAINDER*

	Alloy	Cu.	Fe.	Mg.	Mn.	Cr.	Si.
Wrought-Non-Heat-Treatable	A4	0·03 max.	0·6 max.	—			0·5 max.
	AW3	0·15 max.	0·75 max.	—	10·15		0·6 max.
	AW4	0·15 max.	0·75 max.	1·5–2·5	0·5 max.	0·5 max.	0·6 max.
Wrought Heat-Treatable	AW11	2·0	0·75 max.	0·5–1·25	1·0 max.	—	0·75–1·25
	AW15	3·5–4·8	1·0 max.	1·0 max.	1·2 max.	—	1·5 max.
	AW9	—	0·6 max.	0·4–0·8	—	—	0·3–0·6
	AW10	—	0·6 max.	0·5–1·25	1·0 max.	—	0·75–1·3
Casting Non-Heat-Treatable	AC5	—	0·6 max.	3·0–6·0	0·25–0·75	—	—
	AC4	2·0–4·0	0·8 max.	0·15 max.	0·15 max.	—	0·3–0·6
	AC6	0·1 max.	0·6 max.	—	0·5 max.	—	10·0–13·0
Casting Heat-Treatable	AC9	—	0·6 max.	0·6 max.	0·6 max.	—	10·0–13·0
	AC10	0·15 max.	0·3 max.	9·5–11·0	—	—	0·25 max.

***British Standard STA.7 Specifications must be consulted for full details.**

WROUGHT ALLOYS

The wrought aluminium alloys are divided into two classes, those which obtain their maximum mechanical properties by heat-treatment, and those which harden by working, and are not susceptible to heat-treatment.

The elements most commonly used for alloying aluminium are copper, silicon, magnesium, manganese and nickel. Very small percentages of such metals as chromium or titanium may in some cases be introduced to impart such qualities as fine grain.

While the total number of alloys produced is very large they fall into certain well defined categories and are designed to cover a wide range of uses. Apart from building applications, alloys have been developed for the construction of aircraft, vehicles for road and rail transport, marine work, and the manufacture of domestic and commercial articles generally.

EXTRUDED SECTIONS

The majority of sections used in architectural work are produced by the extrusion process, which consists of forcing the alloy through a die by means of a hydraulically operated ram. The aluminium alloy is previously heated to a state of plasticity. Extruded sections have smooth, clean edges, and surfaces, and are fine in texture, with uniform density. Practically any shape, however, complicated, may be extruded.

The size of section is governed by the capacity of the extrusion press, and the largest machines now operating can produce sections falling within a circle of 14″ diameter.

SHEET AND PLATE

Sheet and plate are produced by normal metal-rolling machinery, the finished material being the result of hot and cold rolling from a cast ingot. Shears, presses, cornice brakes and draw-benches are used for cutting and forming sheet work, and between them these machines can produce almost any shape of a straight-forward design.

A.4 and AW.3 have excellent resistance to corrosion and are the most suitable alloys for this type of work, of which the following are typical applications : roofing, guttering, duct systems, casings, panelling.

Where greater strength than that of AW.3 is required (for example for kicking plates) AW.4 or AW.5 may be specified.

MECHANICAL PROPERTY SPECIFICATIONS FOR EXTRUDED SECTIONS

	Alloy Grade and Temper	0·1 per cent Proof Stress Tons per sq. in.		Ultimate Tensile Stress Tons per sq. in.		Elongation per cent on 2″		Brinell Hardness No. 500 kg. load 10 mm. ball		Density lbs. cu. in.
	STA 7 Spefn.	Min.	Typical	Min.	Typical	Min.	Typical	Min.	Typical	
Non-Heat-Treated Alloys	A4	—	3½	5	5½	27	38	20	25	·098
	AW5	6½	7	14	15	18	20–25	25	30	·099
	AW4	4	5	11	12	18	20–30	40	45	·096
Heat-Treated Alloys	AW11A	10	10¼	17	19	15	15–20	70	75	·100
	AW11B	17	19½	23	24	6–8	8–10	90	95	·100
	AW15A	10–15	16·5	20–25	20–30	8–15	18	95	104	·101
	AW15B	26	28	28	32	8	10	130	135	·101
	AW9A	5	5–7	9	10	18	25	40	45	·097
	AW9B	10	10–12	12	12–16	16	20	71	75	·097
	AW10A	7	9	12	15	18	25	45	60	·097
	AW10B	15	18	18	20	10	15	74	90	·097

MECHANICAL PROPERTY SPECIFICATIONS FOR SHEET

Alloy Grade and Temper		Ultimate Tensile Stress Tons per sq. in.		Elongation per cent on 2 in.
		Min.	Max.	
A4D	Soft	5·0	6·5	15–30 depending on gauge
A4D	½H	7·0	8·5	2–7 ,, ,,
A4D	Hard	9·0	—	1–4 ,, ,,
AW3	Soft	6·0	7·5	20–25 ,, ,,
AW3	½H	7·5	9·5	12 min. ,, ,,
AW3	Hard	11·0	—	5 min. ,, ,,
AW4	Soft	11.0	13.0	18 min. ,, ,,
AW4	½H	15.0	17.0	5 min. ,, ,,
AW4	Hard	17.0	—	3–4 ,, ,,

Note.—¼H and ¾H tempers are also available with intermediate properties.

The 0·1 per cent Proof Stress is not generally given for sheet. It is well below the ultimate stress in the soft tempers, but approaches it closely in the harder tempers.

APPLICATIONS

A.4 (Commercially pure aluminium) in the annealed condition is soft and ductile, although it hardens considerably when worked.

FORMS.—Extruded sections, sheet, plate.
(By controlling the degree of rolling to which the sheet is subjected, varying degrees of temper are obtained. Sheet is normally supplied in five tempers, soft to full hard.)

USES.—Extruded Sections :—
Mouldings, cover strips, etc.

Sheet and Plate :—
Panels, reflectors, spinning, hand beaten work, etc.

AW.3 Slightly harder than A.4, but with similar working characteristics and properties.

Uses.—Sheet for kicking plates, trolley panels, etc.

AW.4 Aluminium-magnesium-chromium alloy.

This wrought non-heat-treatable alloy has extremely good corrosion resistance to industrial and marine atmospheres. It is used for reflector and stressed panels and takes a high polish.

AW.11 and AW.15.

These are the aluminium alloys with high mechanical strength, and are used in the form of extruded sections for structural purposes : owing to the percentage of copper they contain, they are more susceptible to corrosion than other alloys and must be adequately protected.

AW.9 and AW.10

These alloys are the most widely used for architectural purposes ; they will take and retain a high polish, and respond well to the anodic oxidation process.
Their chief uses are for casement sections, hand-rails, balustrades, and constructional and decorative metal work generally.
AW.10 was used for the windows in Sir Giles G. Scott's new Cambridge Library, while AW.9 was used for the same purpose in the new Bodleian at Oxford.

CASTING ALLOYS

Pure aluminium does not possess good foundry characteristics and for purposes of casting is usually alloyed with other elements, such as silicon, copper, magnesium, nickel, etc.
Suitable alloys may be cast by the sand and die casting processes. For architectural purposes sand casting is usually employed, but in cases where large numbers of identical small objects are required the gravity die casting process is quicker and more economical, and the product stronger and better finished.
For decorative work such as window spandrels, the silicon alloys are most widely used. These alloys are highly resistant to corrosion, and under weathering assume a pleasant grey tone. AC.5 and AC.10 have excellent resistance to corrosion, but must be considered as " speciality " alloys, with limited use for architectural purposes.
The magnesium and copper bearing alloys are widely used for casting general engineering components.

MECHANICAL PROPERTY SPECIFICATIONS FOR CASTINGS

NA. Alloy	0·1 per cent Proof Stress Tons per sq. in.		Ultimate Tensile Stress Tons per sq. in.		Elongation per cent on 2 in.	
	Sand.	Chill.	Sand.	Chill.	Sand.	Chill.
(Non-heat-treatable) AC.4	(4)	(4·5)	9	10	2	2
(Non-heat-treatable) AC.5	(5)	(5)	9	11	3	5
(Non-heat-treatable) AC.6	(3½)	(4½)	10½	12	5	7
(Heat-treated) AC.10	(10)	(11)	16	18	7	12

Typical values are bracketed.

FINISHES

In its normally worked state, aluminium is similar to silver in appearance, but with a slightly bluer tinge. However, a great quantity of the material used is given surface treatment, either to improve resistance to corrosion or enhance its decorative value.

ANODIC OXIDATION (ANODISING)

A fresh surface of aluminium, when brought into contact with the air, immediately forms a colourless and transparent coating of oxide, which serves to prevent corrosion of the metal. This coating may be artificially strengthened and thickened by a process in which the metal to be treated acts as the anode in an electrolytic bath, the composition of which varies with different processes used. The coating of oxide can be either transparent or opaque and may, if so desired, be dyed in any colour.
Most interesting decorative effects may be obtained by anodising and dyeing aluminium which has previously been sand blasted. Very remarkable ranges of tone may be obtained by this means, and by good craftsmanship it is possible to reproduce elaborate pictures or patterns with great fidelity.
The various alloys respond in different ways to the anodic process. Silicon alloys (for example AC.6) anodise grey, whilst A.4, AW.9 and AW.10 show the true metallic colour ; generally speaking, it may be said that the purer the metal, the more satisfactory are the results obtained. AC.5, AC.10, AW.9 and AW.10 are all suitable for anodic treatment.

PYLUMINISING

This process, which is patented and available under licence from the Pyrene Co., Ltd., provides a corrosion proof base for paint finishes by means of a chemical dip.

FROSTED FINISH

This finish is obtained by immersing the aluminium in caustic soda, which produces an etched surface covered by a black film. The film may be removed by treating the metal with nitric acid. The resultant surface is light grey in colour and appears as if it had received a fine sand blast.

ETCHING

Etching forms a simple and effective means of producing designs or inscriptions on aluminium sheet. Hydrochloric acid saturated with salt forms a satisfactory etching medium.

SCRATCH-BRUSHING

Scratch brush finishing gives a pleasant and silvery matt surface to the metal. Different combinations or patterns of finish, such as " Swirl finish " may be obtained by variations of this method.

POLISHING

Aluminium and many of its alloys take and retain a very high polish. Reflectors of pure aluminium may be " brightened " electrolytically.

STRUCTURAL INSULATION OF DWELLING HOUSES AND FLATS

By A. C. Hutt, A.M.I.Mech.E.

There is no other single factor which can so effectively contribute to adequate comfort in the house, combined with economy in fuel, as the proper structural insulation of houses, flats and industrial dwellings.

It is generally agreed that the majority of houses have been very inadequately heated in the past. It is also recognised that we must conserve our national fuel resources, and that probably a smaller quantity of fuel will be available for heating than has been used in the past.

Better heating and comfort conditions, combined with fuel economy, can only be effected by adopting a good standard of structural insulation and by using the more efficient heating appliances which are now available.

About 75 to 80 per cent of the heat required to maintain a building or room at a comfortable temperature, goes to make good the heat loss or leakage of heat through the walls, floor and roof. It will be shown that by adopting methods of structural insulation, this heat loss can be reduced by 50 per cent, and greatly increased comfort conditions can be obtained, with an annual saving in fuel of about 20 per cent per house.

The adoption of a high standard of structural insulation only adds about 3 per cent on to the cost of a house.

PRINCIPLES OF STRUCTURAL INSULATION

The reason for structural insulation is to substantially reduce the rate at which heat travels from one side of the walls, roof and floor of a building to the other side and thus greatly minimise leakage of heat through the structure in cold weather, and penetration of heat from the sun in the summer.

Heat is transmitted in three ways :

Conduction

This signifies the rate at which heat will pass through a material, for instance, three or four times the quantity of heat will pass through a 9″ brick wall, compared to the rate of heat transference through 1″ of good insulating material.

Radiation

This is dependent on the surface of the material ; a smooth or bright metal surface reflects back radiant heat. Aluminium foil is the material usually used as a reflective insulator.

Convection

The heat transferred to and from air moving over a surface which is hotter or colder than the air temperature.

The most generally known and efficient example of heat insulator is the ordinary vacuum flask, which has a glass container with hollow walls and a fairly high vacuum in the wall space. The vacuum space acts practically as a non-conductor of heat, the surfaces of the walls are silvered, and this reduces loss of heat by radiation ; and as there is practically no air to circulate in the vacuum space the loss of heat by convection is reduced to a minimum.

If it were possible to construct houses incorporating this principle in the structure only a very small quantity of heat or fuel would be required to maintain a comfortable temperature even under the severest conditions.

Next in effectiveness to a vacuum is a layer of still air especially if radiation across it can be minimised. Air will only remain still when it is confined to small spaces or cells, and insulating materials—that is, materials which will only allow heat to travel very slowly through them—are almost invariably composed of such minute spaces or cells, and the more there are of these in a given volume the better will be the insulation value of the material. For this reason it can generally be said that the lighter the material the better its insulation value or quality since the ratio of the volume of air contained to that of the solid material forming the walls of the cells will be greater.

The other system of insulation is sometimes termed *Reflective Insulation ;* specially prepared

aluminium foil which retains a bright surface is usually used for this purpose. Either single thin sheets are used, or a reinforced aluminium foil comprising a thin sheet of stiffening material with aluminium foil sheets attached to the surfaces. Aluminium foil is generally fixed so as to leave an air space between the structures of the building and the foil, so that the combined benefit of an air space and reflective insulation is obtained.

Heat Transmittance

The loss of heat or heat leakage through structural materials of a building is usually expressed by the symbol U which is the heat (or thermal) transmittance in British thermal units, per sq. ft., per hour, per degree Fahrenheit temperature difference between the air inside and outside the building.

For example, the thermal transmittance U of a 9″ solid brick wall plastered is 0·43 and, assuming a 20°F. temperature difference between the air inside and outside the wall, the heat loss through an area of 500 sq. ft. would be $0{\cdot}43 \times 500 \times 20 = 4{,}300$ B.Th.U's per hour or 103,200 B.Th.U's per 24 hours.

B.Th.U's Equivalent in Fuel

The number of British thermal heat units in, or the calorific value of, one pound of ordinary household coal or coke is about 12,000 and, as the best modern heat appliances have an efficiency of at least 50 per cent, one pound of fuel will provide about 6,000 effective B.Th.U's of heat.

In the example shown above the 103,200 B.Th.U's heat loss would be equivalent to $\frac{103{,}200}{6{,}000}$ $= 17{\cdot}2$ lb. of fuel in 24 hours.

If an old type open coal fire were used, which has an overall efficiency of only 25 per cent to 30 per cent, a proportionally greater quantity of fuel would be required to make good the heat loss through the wall since the effective B.Th.U's from the pound of coal would only be between 3,000 and 3,600.

Outside Air Temperature

The average outside air temperature in the South and Midlands of England is generally accepted as being 43°F. during the 26 weeks in the year when heating is normally required. It is rather lower in the North of England.

Inside Air Temperature

For a reasonable standard of comfort it is usually assumed that the living-room should be maintained at a temperature of 60°F. to 65°F. throughout the day, dropping to 50°F. or 55°F. during the night, and that bedrooms and other rooms which are used should be maintained at a temperature of 50°F. or 55°F. This partial heating of bedrooms is commonly referred to as background heating.

From the above it will be seen that if the U value for any particular structure is known, it is a simple matter to estimate the heat loss through the structure for any particular conditions.

STANDARD OF STRUCTURAL INSULATION

Table I shows the heat loss or thermal transmittance " U " through the walls, ground floor and roof of a conventional type of brick house, compared to figures in the last column for a similar house with walls, floor and roof of insulated construction to the standard, as recommended in " Heating and Ventilation of Dwellings," Post-War Building Studies, No. 19 (H.M.S.O.), page 46.

TABLE I

Traditional Brick House Construction. Heat Transmittance " U " (B.Th.U's/sq. ft./hr./°F.)	*Recommended Insulated Construction* Heat Transmittance " U "
Floor : Timber boarding on timber joists ... 0·35	0·15
Walls : 9″ brick plastered 0·43	0·2
Roof : Tiles on battens over plaster ceiling ... 0·56	0·2

From the table it will be seen that the heat loss through the outer structure of a house can be halved by adopting an insulated form of construction.

COST OF MATERIALS AND METHODS OF INSULATED CONSTRUCTION

The cost of structural insulation materials and methods of construction may vary according to the district. A light-weight low-conductivity material for wall construction, such as foamed slag concrete, may be used in districts where it is readily available at little or no extra cost, whereas, in localities where building bricks or concrete are more readily obtainable and used, other materials and methods of insulation can be adopted.

Low heat conductivity insulating materials are all light in weight, and this reduces transport and handling costs compared to the older and more conventional building materials. Any increased cost of insulating materials may often be offset by the saving in cost of erection ; for instance, the substitution of insulating board or suitable low conductivity building slabs in place of lath and plaster may effect a saving in time in fittings, which offsets the greater cost of the material.

The increased cost of building a small house to a good or high standard of structural insulation will be in the order of £20 to £35. In other words, the cost of adopting a high standard of structural insulation will only add about 3 per cent on to the cost of a house.

The roof space of a new or existing house can be insulated at a cost of £5 to £7. The insulating material (costing £3 10s. to £5) can be laid in the roof space, between the top ceiling rafters, by unskilled labour.

ADVANTAGES OF STRUCTURAL INSULATION

(a) *Fuel Economy in Relation to cost of Insulation*

The average quantity of solid fuel used in Great Britain for domestic purposes has been about 4½ tons per household per annum, exclusive of the solid fuel used in the production of gas and electricity for domestic purposes.

Probably the smaller households have used 3½ to 4 tons of solid fuel per annum, of which about 2¼ to 2¾ tons have been used for space heating and the remainder for hot water supply and cooking.

New Houses

Building a small house to a good standard of structural insulation at an extra cost of about £20 to £35 can effect a saving in fuel of 10 to 15 cwt. per annum, or £2 to £3 fuel cost.

New or Existing Houses

Insulating the roof space of a new or existing small house will involve an extra cost of about £5 to £7 and effect a saving of 4 to 5 cwt. of fuel per annum, or 16s. 0d. to £1 in fuel cost.

Fuel Saving and Comfort

The saving in heat loss by adopting structural insulation will probably not result in an equivalent saving in fuel, and in arriving at the above figures it has been assumed that about half the heat saved will be utilised in better heating and more comfortable living conditions which cannot be assessed at a cash value, and half will represent the actual saving in fuel used.

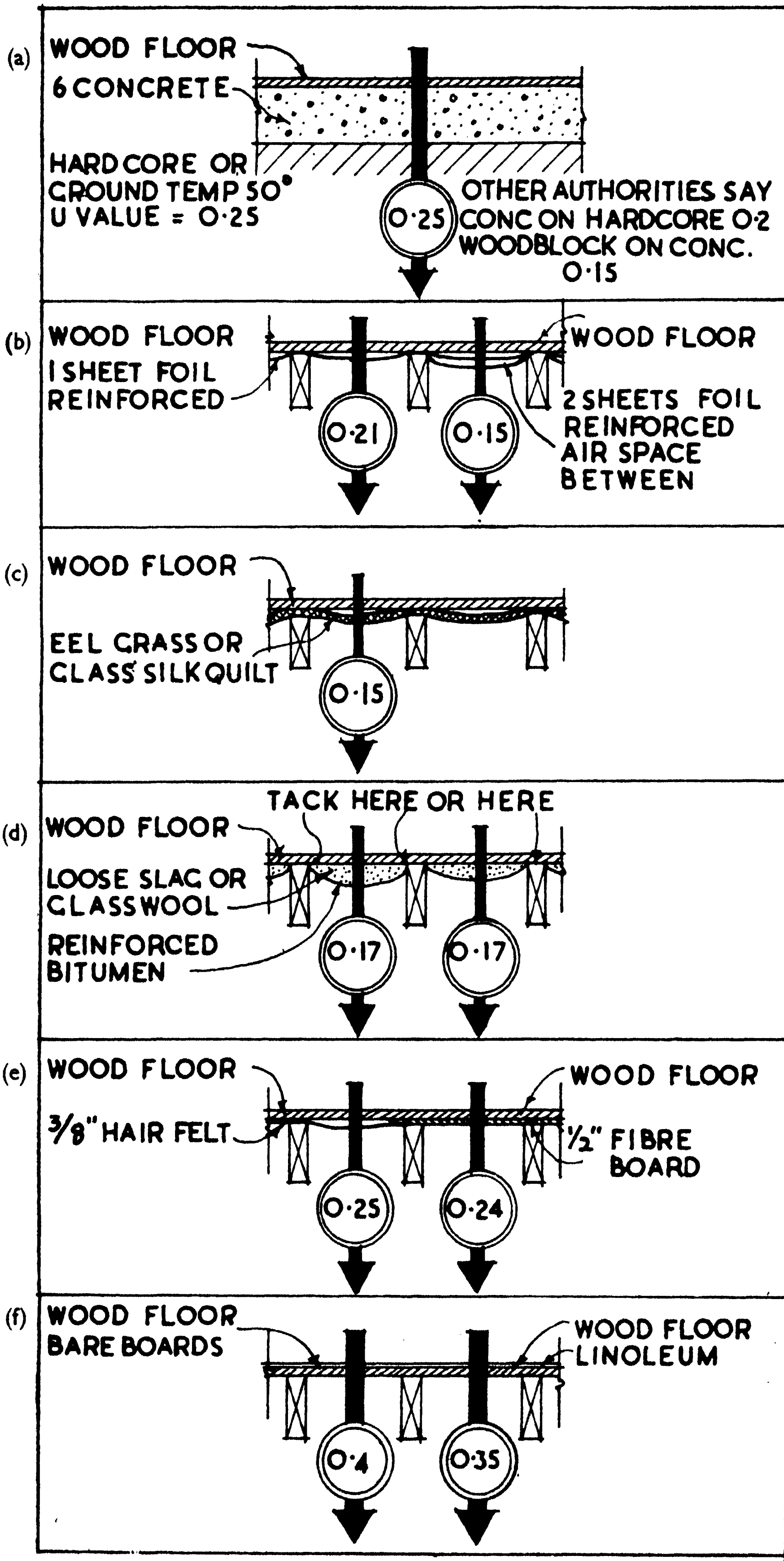
(b) *Quicker Warming of Rooms*

Rooms which are intermittently heated take some time to heat up, and are not comfortable until the inside surface of the walls heat up to nearly the required air temperature inside the room. The time taken to heat up a room depends largely on the thermal capacity of the walls—that is, the quantity of heat they absorb in warming up.

As an example, a room with a plastered brick wall which has a high thermal capacity may take 1½ hours to warm up, whereas the addition of a thin layer of insulating material of low heat capacity will reduce the time of warming up to half an hour, which represents both convenience and a considerable saving in fuel consumption.

(c) *Room Temperatures*

It is too commonly assumed that if the air temperature in a room is maintained at 60°F. or 65°F. the room would be well heated and comfortable ; but this is not necessarily the case. If the heat loss through the walls of the room is high the temperature of the surface of the walls will be considerably lower than the air temperature in the room, and this will produce a chilling effect. Under winter conditions it is necessary to maintain the temperature of the inside air at about 5°F. higher in a room with 9″ plastered brickwork than in one with walls of recommended insulated construction, in order to give a similar feeling of comfort.



	"U" VALUE	HEAT LOSS EQUIVLT IN CWT OF FUEL PER YEAR PER 500 SQ FT		
		ROOM TEMP F.		
		50°	55°	60°
(a)	0·25 TO 0·15		4·1	8·3
(b)	0·21	4·8	8·2	11·6
	0·15	3·4	5·8	8·3
(c)	0·15	3·4	5·8	8·3
(d)	0·17	3·9	6·6	9·4
(e)	0·25	5·7	9·7	13·8
	0·24	5·5	9·3	13·2
(f)	0·4			
	0·35	7·9	13·6	19·3

Figure 1

(d) Cooler Houses in Summer

Just as insulated construction reduces the outward loss of heat from a building in the winter, so also it retards the penetration of heat into the building on hot summer days, with a result that the building keeps cooler and more comfortable.

(e) Ventilation and Health

Inefficient and inadequate means of heating, particularly bedrooms, has resulted in many people sleeping with windows and doors tightly closed. The inadequate ventilation under these conditions is certainly detrimental to health. On the other hand, it is wasteful to allow heat to escape unnecessarily through open windows. Ventilation should be planned so as to ensure sufficient air entering and leaving the building to give healthful conditions without causing draughts.

(f) Sound Insulation

The desirability of reducing sound penetration, particularly through partition walls and through floors of flats, is beginning to be recognised. It is not intended to deal with the principles of sound insulation except to point out that many structural insulation materials may be fitted in such a way that they combine both thermal and sound insulating forms of construction. Further information on this point can be obtained from the manufacturers of structural insulating materials.

(g) Heating Period reduced

In early and late winter it is often comparatively warm during the day but it becomes chilly in the evenings, so that a fire is required. In a house built to a good standard of insulated construction the indoor temperature does not change nearly so quickly with a fall in the outside temperature, and fires may be unnecessary until a week or two later in the autumn, and may be dispensed with a week or two earlier in the spring, resulting in an appreciable saving in fuel.

(h) Avoidance of Condensation

In a well insulated structure there is little difference between the wall surface and air temperature ; this greatly decreases the possibility of condensation and damage to interior decoration.

METHODS OF INSULATION

Some of the principal and typical methods of insulating ground floors, walls and roofs will be described. The illustrations show the heat transmission U through various structures and there are tables showing the heat loss equivalent in cwt. of fuel per annum per 500 sq. ft. of typical forms of insulated structure.

Heat losses are given in cwt. of fuel because the significance of the figures can be more readily appreciated than would be the case if they were given in terms of British thermal units.

The figures for heat losses are given per 500 sq. ft. of floor, wall or roof because the ground floor and roof area of a small house are each about 450 to 500 sq. ft. and it also happens that the wall area of the ground or first floor of a small semi-detached house is about 500 sq. ft., as the length of the three exposed walls is about 65′ and the rooms are about 8′ high $65 \times 8 = 520$ sq. ft. There will be more than 20′ of window space not affected by insulation.

(a) Ground Floors

The heat loss through ordinary ground floors is not as great as that through walls or roof, but a cold floor may be the cause of considerable discomfort. The desirability of insulating the floor assumes greater importance because for some time to come it will be difficult to obtain adequate carpets, which have provided a reasonable heat insulating cover to floors in the past.

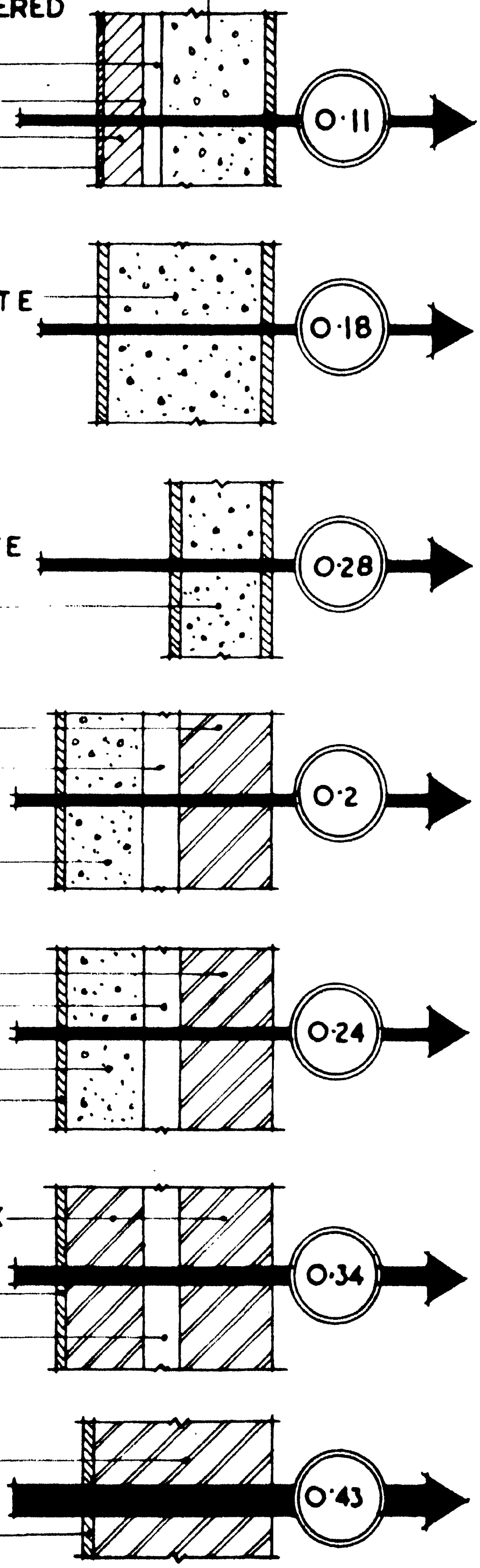
The following are typical of some of the simplest and best methods of insulating the ground floor :

FIG. 1f. shows the heat loss through 1″ (nominal) tongued and grooved boarding on timber joists, ventilated under and covered with linoleum.

FIG. 1a. shows a 1″ (nominal) wood block floor on concrete on ground.

FIG. 1b. shows the method of draping reinforced aluminium foil over the floor joists, allowing it to droop about 2″ below the top of the joists, and then nailing down the floor in the ordinary way. A higher degree of insulation is obtained by using two sheets, with an air space between each.

FIG. 1c. shows a simple but probably more expensive method of draping a quilt of glass wool slag wool or eel grass over the joists and nailing down the floor with the blanket nipped between the floor boards and joists.



		"U" VALUE	HEAT LOSS EQUIVALENT IN CWT OF FUEL PER YEAR PER 500 SQ FT OF WALL ROOM TEMP 50°	55°	60°
(a)	6" FOAMED SLAG CONCRETE RENDERED AIR SPACE UNVENTILATED BUILDING PAPER 2" WOOD WOOL PLASTER	0·11	2·5	4·3	6·1
(b)	8" F.S. CONCRETE RENDERED & PLASTERED	0·18	4·1	7·0	9·9
(c)	4" F.S. CONCRETE RENDERED & PLASTERED	0·28	6·4	10·9	15·5
(d)	4½" BRICK 2" CAVITY UNVENTILATED 4" F.S. CONCRETE PLASTERED	0·2	4·5	7·8	11·0
(e)	4½" BRICK 2" CAVITY UNVENTILATED 4" BREEZE PLASTER	0·24	5·5	9·3	13·2
(f)	11" CAVITY BRICK PLASTER 2 CAVITY VENTILATED	0·34	7·7	13·2	18·8
(g)	9 BRICK PLASTER	0·43	9·8	16·8	23·8

Figure 2

It may be of interest to note that this method of nailing down a quilt of insulating material below a floor is a usual way of obtaining a high degree of sound insulation through the floors of adjacent flats.
FIG. 1d. A reinforced bitumen roofing felt is draped over the floor joists, and the drooping sheet between the joists is filled up to floor level with insulation material such as slag wool or glass wool, and the floor then nailed down.
FIG. 1e. This shows a method of laying felt, or insulating board, across the floor joists. If felt is used it may be desirable to support the felt on a sheet of reinforced bitumen roofing felt.
The methods of insulating described will reduce the heat transmittance U from 0·35 to 0·15.

(b) Walls

Walls of low heat conductivity may be constructed either by :

1. The use of low conductivity building materials.
2. Providing air spaces in the walls.
3. The addition of suitable insulating lining to ordinary brick or concrete walls.
   Or by a combination of these methods.

Walls of low conductivity material.—FIG. 2. There are various low conductivity building materials which may be used in place of brickwork, as follows :

> Foamed Slag Concrete.—This is a light-weight concrete made with special slag aggregate. It has almost the same structural strength of ordinary concrete and may be obtained in blocks, or for casting in situ. Owing to its light weight it does not require heavy shuttering, and light shuttering of expanded metal in a wood frame can be used. Production of this material in 1946 was sufficient for building about 8,000 houses per annum, with expanding output.
> Expanded Clay and No-Fines Concrete.—These are other forms of low conductivity concrete which have been used.
> Breezeblocks and Breeze Concrete.—These have been used for many years, and their conductivity is lower than that of ordinary bricks, but the structural strength is low.

FIG. 2 shows various types of wall construction ; the thermal transmittance U is shown against each. The last three columns show the heat leakage or loss expressed in terms of fuel per annum through the outer walls of rooms maintained at different temperatures throughout the six winter months.
The heat leakage through 500 sq. ft. outer 9″ brick wall of a room maintained at 60°F. will be equivalent to 23·8 cwt. of fuel per annum, whereas with the best type of insulated wall it will be only 6·1 cwt. The difference in heat loss is equivalent to a saving of 23·8 — 6·1 = 17·7 cwt. fuel per annum.
If the living-room were maintained at 60°F. during the day and 50°F. during the night, the saving would be equivalent to 12·9 cwt. of fuel per annum per 500 sq. ft. of outside wall.

Brick Walls with Insulating Lining.—FIG. 3b. In many cases ordinary brick is the most readily obtainable material for walls, and FIG 3b shows some typical methods of insulating such walls.
The cost of providing and fitting this type of insulation usually ranges from 8d. to 1s. 2d. per sq. ft. In cases where a lining of hard board is adopted, no plastering is required and therefore the cost of this can be offset against the cost of insulating lining.

Concrete Panel Walls with Insulated Lining.—FIG. 3a. A number of steel-framed houses are being erected with concrete panel walls about 2″ thick ; the heat loss through these walls is high (U = 0·78) and such walls must be insulated. Some typical methods of insulation are shown in FIG. 3a.
The upper illustration, FIG. 3a, shows the effect of fitting a single reinforced aluminium foil sheet with an air space each side of it. If two aluminium foil sheets are fitted ¾″ apart, forming three air spaces, the U value would be reduced to 0·12.
The centre illustration, FIG 3a, shows the method of insulating with slag wool, glass wool or other suitable insulating material. When using such materials it is necessary to fit a sheet of aluminium foil, or suitable moisture-proof building paper, to form a " moisture barrier," otherwise there is a possibility of moisture condensing on the inside of the concrete panel.
The cost of such insulation is 8d. to 1s. 2d. per sq. ft., but the cost of plastering is avoided if the inner lining is in the form of panels or hard board, or insulating board, which do not require any plaster finish.

(a)

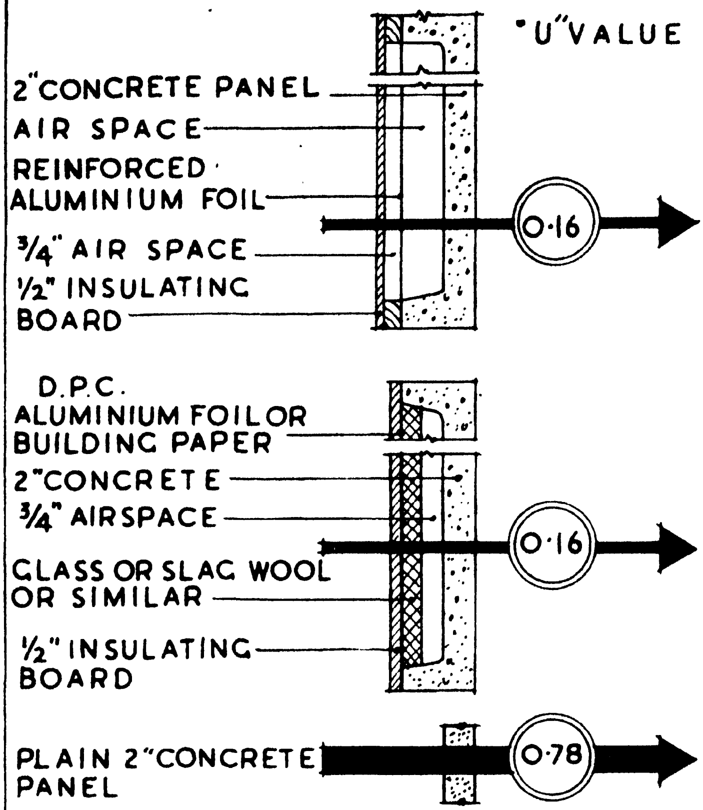


FIG 3A. INSULATING CONCRETE PANELS OR SHEET METAL WALLS

(b)

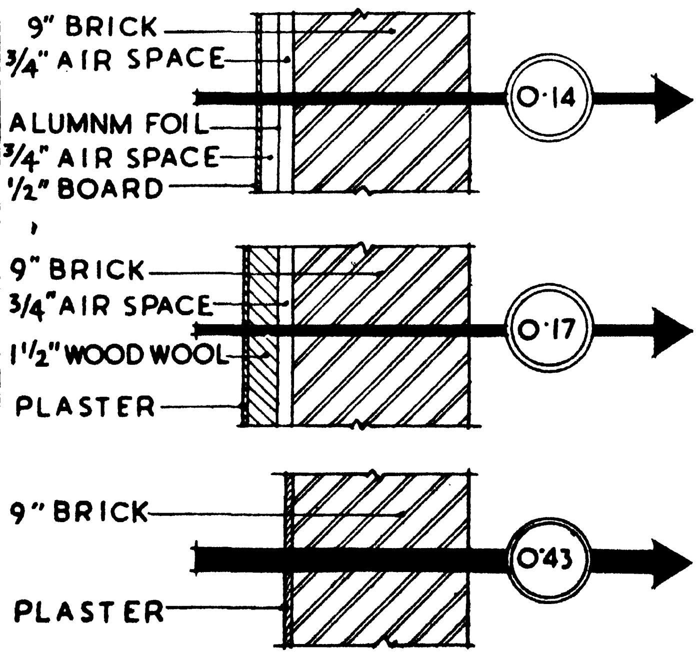


FIG 3B INSULATING BRICK WALLS BY LINING (OLD OR NEW HOUSES)

HEAT LOSS EQUIVALENT IN CWT OF FUEL PER YEAR PER 500 SQ FT OF WALL

ROOM TEMP F		
50°	55°	60°
3·6	6·2	8·8
3·6	6·2	8·8
17·7	30·4	43·1
3·2	5·5	7·7
3·9	6·6	9·4
9·8	16·8	23·8

Figure 3

Walls of Steel or Asbestos Sheets with Insulating Lining.—FIG. 3a. The heat loss through steel or asbestos sheets is very high (U = 0·9 to 1·3); the methods of insulating such walls are similar to those adopted for 2" concrete panel walls (see FIG. 3a).
It is of interest to note that the aluminium temporary houses have walls comprising an outer and inner skin of aluminium, with 4" foamed slag concrete poured between them.

Windows.—The heat loss through single glazing is high (U = 1·00) and for a room in an exposed position with a large window area it will be advisable to consider the use of double windows, which will reduce the heat loss by half. The second pane of glass should be fixed in a removable or hinged frame to enable all surfaces to be accessible for cleaning. A removable frame can be stored during the summer months, when its use is unnecessary.

Conditions where insulation of walls is particularly desirable. (New or Existing Houses).—There are circumstances where a high standard of insulated construction is especially needed ; for instance, the wall of a living-room exposed to strong north or east winds particularly requires to be well insulated. It is in some cases impossible to keep such a living-room warm, even by using a wasteful amount of fuel, because an exposed east or north wall conducts heat away so rapidly that the surface is cold and chills the occupants ; the obvious remedy is to adopt an insulated form of construction, or in the case of existing houses to line the very exposed walls with insulating materials, as shown in FIG. 3b.
It is impossible to adequately heat a large room exceeding 200 sq. ft. with an open fire, particularly if it has a large area of windows or outside walls facing north or east. In such a room one can be "roasted" in front by radiant heat from a large open fire and still have an uncomfortably cold and chilly back. Provision of an insulated lining to the exposed walls will effect a great improvement, though to make a room really comfortable it may be necessary to fit a modern efficient convector open fire with back boiler, coupled to hot water pipes and radiators suitably fixed round two walls of the room. This equalises the heat distribution and will effect an economy in fuel.

(c) *Roof Insulation*

New or Existing Buildings.—The roof space of new and most existing houses can be easily insulated without skilled labour.
The heat losses from the upper rooms of a house, through the plaster ceiling, roof space and ordinary tiled roofs, also the heat loss of a room insulated (to the standard as recommended in "Heating and Ventilation of Dwellings," Post-War Building Studies, No. 19 (H.M.S.O.), (page 46) are given in Table 2.
The last two columns show the heat loss, or leakage, through roof expressed in terms of cwt. of fuel per annum. The loss is shown per 500 sq. ft. of roof area, as this is the size of roof of an ordinary small house. It will be seen that if a bedroom is maintained at 50° the effect of insulating the roof space below a plain tiled roof will save leakage of heat equivalent to 12·8 — 4·5 cwt. or 8·3 cwt. of fuel per annum.

TABLE 2.—HEAT LOSS THROUGH TILED ROOFS

Construction	*Heat Transmittance or leakage* U	*Heat Loss per 500 sq. ft. of roof equivalent in cwt. of fuel per annum.* Room Temperature 50°F.	55°F.
Tiles on battens	0·56	12·8	21·8
Tiles on battens, felted	0·46	10·5	18·0
Tiles on battens felted and boarded*	0·3	6·8	11·7
Recommended standard of insulated construction	0·2	4·5	7·8

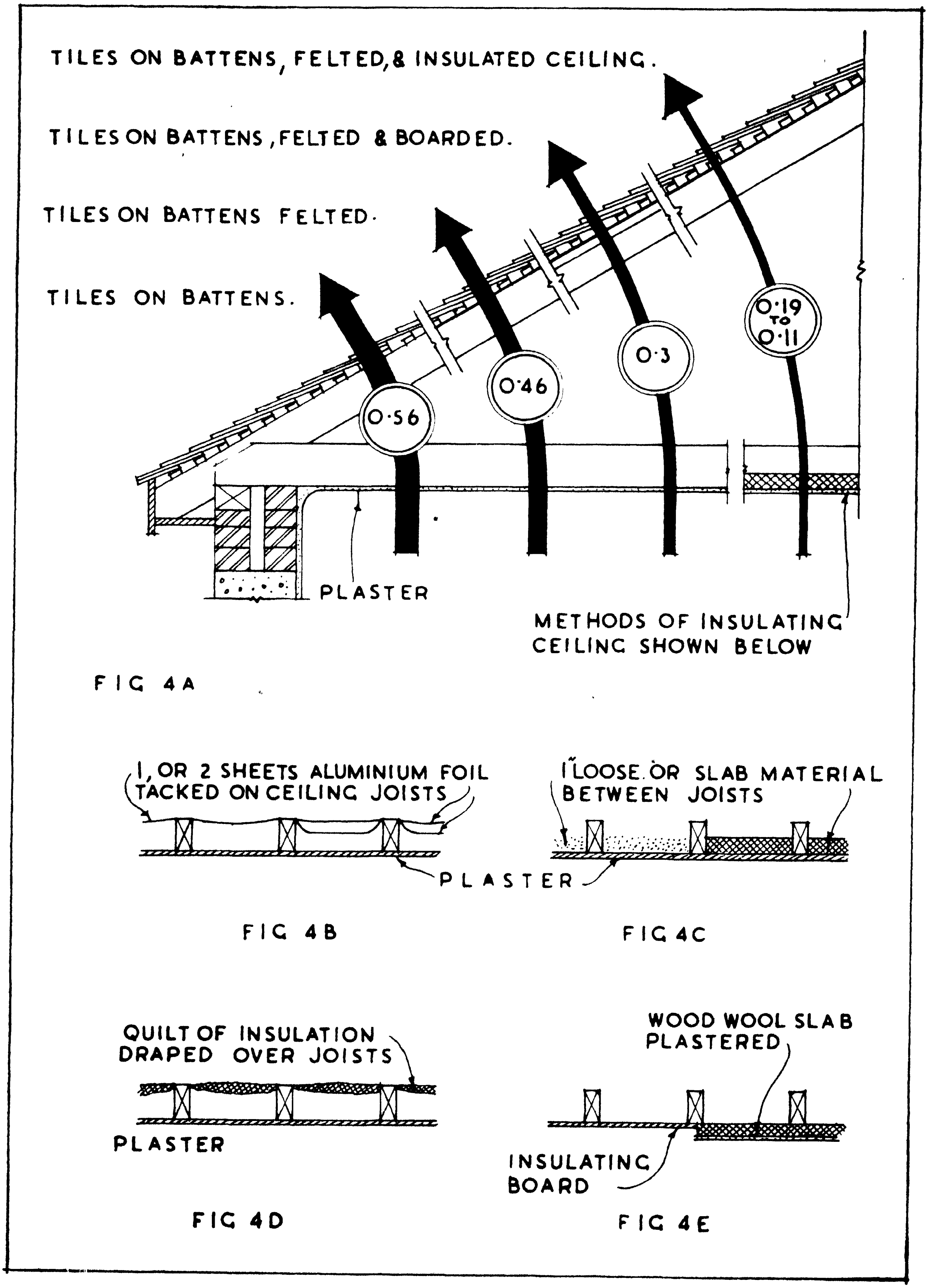

TILES ON BATTENS, FELTED, & INSULATED CEILING.
TILES ON BATTENS, FELTED & BOARDED.
TILES ON BATTENS FELTED.
TILES ON BATTENS.
0·56
0·46
0·3
0·19 TO 0·11
PLASTER
METHODS OF INSULATING CEILING SHOWN BELOW
FIG 4A
1, OR 2 SHEETS ALUMINIUM FOIL TACKED ON CEILING JOISTS
PLASTER
FIG 4B
LOOSE OR SLAB MATERIAL BETWEEN JOISTS
FIG 4C
QUILT OF INSULATION DRAPED OVER JOISTS
PLASTER
FIG 4D
WOOD WOOL SLAB PLASTERED
INSULATING BOARD
FIG 4E

Figure 4

The figures for heat loss in this table and also throughout this memorandum, are based on a heating period of 26 weeks per year.

*The better class of roof construction has, in the past, been boarded but timber for this purpose is unlikely to be available for some considerable time to come.

The simplest and cheapest method of reducing the heat loss through the roofs of new or existing houses, is to lay suitable insulation material in the roof space, between the joists and on top of the plaster ceiling (see FIG. 4). Suitable insulating material can be supplied either in the form of loose material, sheets of various thickness or in the form of quilts or sheets for draping over the ceiling rafters.

Insulating materials laid in these ways will reduce the heat loss, as follows :

	Heat Loss U.
Approximately 1″ thickness of good insulation or one sheet of reinforced aluminium foil	0·19
1½″ thickness of insulation or two sheets of reinforced aluminium foil ...	0·11

A more detailed list of methods of insulation and heat loss equivalent in cwt. of fuel per annum is given in Table 3.

TABLE 3.—ROOF INSULATION

	"U" value	*Heat loss equivalent in cwt. of fuel per year per 500 sq. ft.* Room Temperature 50°F.	55°F.	60°F.
1. Tiles on battens ; attic space, plaster ceiling	·56	12·8	21·8	30·9
2. Tiles on battens felted ; attic space, plaster ceiling ...	·46	10·5	18·0	25·4
3. Tiles on battens felted and boarded ; attic space, plaster ceiling	·30	6·8	11·7	16·6
4. Tiles on battens felted ; attic space, Fig. 4b. 1 sheet of reinforced Aluminium Foil draped over joists. Plaster ceiling	·19	4·3	7·4	10·5
5. Tiles on battens felted ; attic space. Fig. 4b. 2 sheets of reinforced Aluminium Foil draped over joists, plaster ceiling	·15	3·4	5·8	8·3
6. Tiles on battens felted ; attic space, Fig. 4c. 1″ slag or glass wool or 1½″ sawdust between joists. Plaster ceiling	·19	4·3	7·4	10·5
7. Tiles on battens felted ; attic space, Fig. 4d. 1″ Quilt of Eel Grass or Grass Silk over joists. Plaster ceiling ...	·15	3·4	5·8	8·3
8. Tiles on battens felted ; attic space Fig. 4d. 1½″ wood wool slabs plastered over joists	·21	4·8	8·2	11·6
9. Tiles on battens felted ; attic space. ½″ insulation board under joists	·30	6·8	11·7	16·6
10. Tiles on battens felted ; attic space. ½″ insulation board over joists. Plaster ceiling	·21	4·8	8·2	11·6

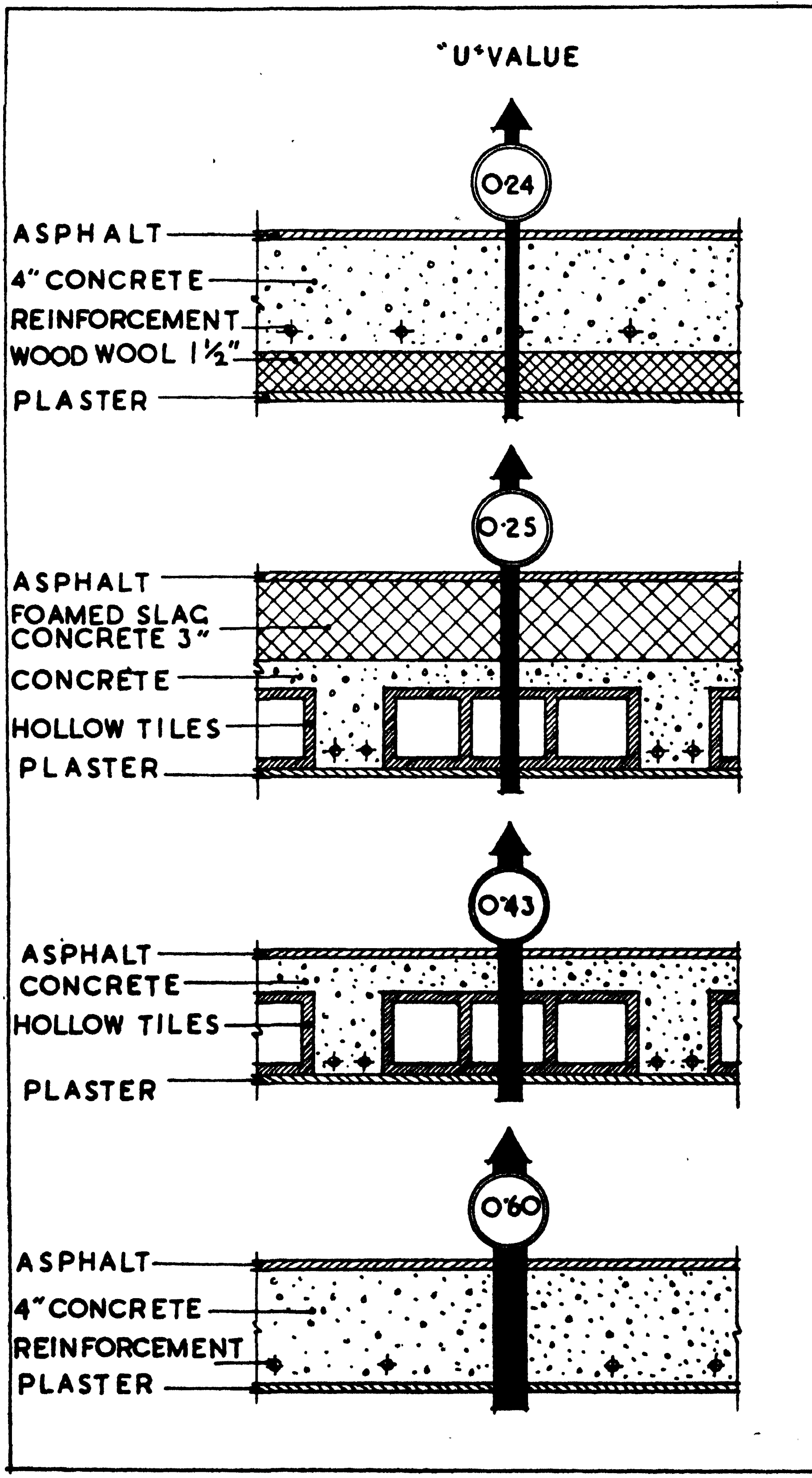
Methods of roof insulation are illustrated in FIG. 4, as follows :

Loose Material (FIG. 4c).—There are various materials, such as slag wool, glass wool, granular expanded mica, etc., which can be spread between the ceiling joists.

Sheet Material (FIG. 4b).—These include slag wool, bitumen bonded glass wool, etc. Sheets may be cut to fit between ceiling joists.

Quilted Material (FIG. 4d).—Eel grass, glass wool, slag wool, etc., can be obtained in the form of a quilt suitable for draping over the ceiling joists.

Aluminium Foil (FIG. 4b).—Either one or two sheets of reinforced aluminium foil may be draped over the ceiling joists, leaving a 1″ air space between the ceiling and foil sheet, and if two sheets of foil are fitted there should be 1″ air space between them.



HEAT LOSS EQUIVALENT IN CWT OF FUEL PER YEAR PER 500 SQUARE FEET OF ROOFING.		
ROOM TEMP F.		
50°	55°	60°
5·5	9·3	13·2
5·7	9·7	13·8
9·8	16·8	23·8
13·6	23·4	33·1

Figure 5

New Houses (FIG. 4c).—In new house construction, as an alternative to the methods of insulating the roof space, insulating boards or slabs, such as wood wool building slabs, may be used in place of a lath and plaster ceiling below the roof space. The higher cost of these boards or slabs may be offset by a saving in labour for fixing. Wood wool building slabs have a very good key surface for a plaster finish.

Values of "U" for typical flat roofs are given in figure 5.

FACTORY INSULATION

It is not the purpose of this memorandum to deal generally with the matter of factory insulation, though structural insulation of factories is as important as that of houses ; in fact, the heat loss per sq. ft. from the usual factory structures is greater than from houses and therefore, the savings which can be effected are greater.

The structural insulation of factories is dealt with fully in "Thermal Insulation of Buildings," Fuel Efficiency Bulletin, No. 12—obtainable from the Ministry of Fuel and Power.

The following are a few salient points regarding structural insulation and savings in fuel :

1. The majority of factory roofs are of corrugated asbestos cement sheet ; thermal transmittance U = 1·4. By lining such roofs with ½" insulating board, or other suitable material, the U value is reduced to 0·38.
2. The cost of providing insulating lining is 6d. to 9d. per sq. ft. applied to a new factory in course of erection, and about 9d. to 1s. 3d. per sq. ft. for fitting to an existing factory.
3. Lining 500 sq. ft. of corrugated roof will effect a saving in heat losses equivalent to 2½ tons of fuel, or say £7 10s. in fuel cost.

The approximate cost of lining is as follows :

New Factory : 500 sq. ft. at 9d. = £18 15s. 0d.
Old Factory : 500 sq. ft. at 1s. 3d. = £31 15s. 0d.

It will be seen from these figures that the extra cost of structural insulation of a new factory will be repaid in 2½ years by savings in fuel cost, and the cost of applying insulation to an existing factory will be repaid in four years.

EXAMPLES OF SAVINGS IN HEAT LOSS AND FUEL

(a) Through Roof (New or Existing Houses).

The following example shows saving in fuel which may be effected by fitting insulation between the ceiling joists in the attic or roof space of a small house 21 × 24′ = 500 sq. ft., assuming a pitched roof with tiles or battens :

Heat Losses.

Tiles or battens. Heat Loss "U" ...	0·56*
Tiles or battens with insulation as proposed	0·20
Saving in "U" value	0·36

* If roof were felted this figure would be 0·46 and the saving effected in "U" value by addition of insulation would be 0·46—0·20 = 0·26.

Temperature average for six winter months.

Upstairs rooms assumed to be	50°F.
Outside air temperature	43°F.
Temperature difference	7°F.

	Area		Saving "U" figure		Temperature difference
Heat savings =	500	×	·36	×	7

= 1,260 B.Th.U/hr.
= 30,240 B.Th.U/24 hrs.

Fuel Saving. Assuming efficiency of heating appliance = 50%
Calorific value of fuel = 12,000 B.Th.U/lb.
Effective B.Th.U. per lb. of fuel = 6,000.

Heat saving is equivalent to $\frac{30,240}{6,000}$ = 5 lb. fuel per day.

Heat saving is equivalent to $\frac{5 \times 180}{112}$ = 8 cwt. fuel per annum.*

* If a similar comparison is made, assuming that the bedroom is maintained at a temperature of 55° F. the saving in heat leakage would be equivalent to 13·7 cwt. of fuel.

(b) Ordinary House Compared with Insulated House.

Ordinary Brick House.—This is assumed to have 9" brick walls, wood floor on joists and tiled roof on battens with plaster ceiling below.

Assuming that, for the six winter months, the ground floors are maintained at 60°F. during the day and 50°F. during the night (average 55°F.) and that the bedrooms are maintained at 50°F. throughout, the heat loss equivalent in fuel would be :

	Room Temperature	Heat Transmittance "U"	Heat Loss equivalent in cwt. of fuel per annum
	°F.		
Ground Floor	55	·35	13·6
Ground Floor walls	55	·43	16·8
First Floor walls	50	·43	9·8
First Floor ceiling and roof	50	·56	12·8
			53 cwts.

Insulated House.—If we assume that this house is built to the standard of insulated construction recommended on page 00, and if we presume that the bedrooms are maintained at 55°F. instead of the 50°F. assumed for the ordinary brick house, and living room at 60°F. instead of 55°F., the heat loss equivalent in fuel would be :—

	Room Temperature	Heat Transmittance "U"	Heat Loss equivalent in cwt. of fuel per annum
	°F.		
Ground Floor	60	0·15	8·3
Ground Floor walls	60	0·2	11·0
First Floor walls	55	0·2	7·8
First Floor ceiling and roof	55	0·2	7·8
			34·9 cwts.

From the above figures it will be seen that in a house built to a good standard of insulated construction the inside temperature could be maintained at 5°F. higher throughout and at the same time a saving of fuel of 18 cwts. per annum could be effected.

MANUFACTURERS OF STRUCTURAL INSULATING MATERIALS

1. *Aluminium Foil.* Alfol Insulation Ltd., 68 Victoria Street, S.W.1.
   Ardor Insulation Co., Ltd., 8, Southampton Row, W.C.1.
2. *Asbestos—Sprayed Asbestos.* Magnesia-Asbestos-Glass Insulation Manufacturers Council, Everite House, 59½, Southwark Street, S.E.1.
3. *Compressed Felt.* Pressed Felt Manufacturers' Association, Sissclough Works, Waterfoot, Rossendale, Lancs.
4. *Corkboard.* Corkboard Association, 10, Leigham Hall Parade, Streatham High Road, S.W.16.
5. *Eel Grass.* Huntley & Sparks, Ltd., De Burgh Road, South Wimbledon, S.W.16.
6. *Foamed Slag.* Foamslag (Tee-Side Production) Ltd., 13/14 Dartmouth Street, S.W.1.
   Slag Aggregates Ltd., Santon, Scunthorpe, Lincs.
7. *Glass Wool.* Fibreglass Ltd., 10, Princes Street, S.W.1.
   Versil Ltd., Rayner Mills, Liversedge, Yorks.
8. Insulation, Building and Hard Board Association, Columbia House, Aldwych, W.C.2.
   TenTesT Fibre Board Co., Ltd., 75, Crescent West, Hadley Wood, Barnet.
9. *Slag Wool Mineral Wool.* Slag Wool Association, Cheyne House, 62/63 Cheapside, E.C.2.
   F. McNeill & Co., Ltd., 10, Lower Grosvenor Place, S.W.1.
   Frederick Jones & Co., Ltd., 1, Perren Street, Kentish Town, N.W.5.
   Stillite Products Ltd., Sardinia House, Kingsway, W.C.2.
10. *Wood Wool.* Wood Wool Building Slab Manufacturers' Association, 11, Ironmonger Lane, E.C.2.
    Gyproc Products, Ltd., 21, St. James's Street, S.W.1.
    Lithalun Products, Ltd., Pontalun, Bridgend, Glam.
    The Cementation Co., Ltd., 39, Victoria Street, S.W.1.
    The Marley Tile Co., Ltd., Riverhead, Sevenoaks, Kent.
11. *Various.* Gyproc Products Ltd., 21, St. James's Street, S.W.1. (Makers of Insulex and Zonalex loose fill insulating materials.)

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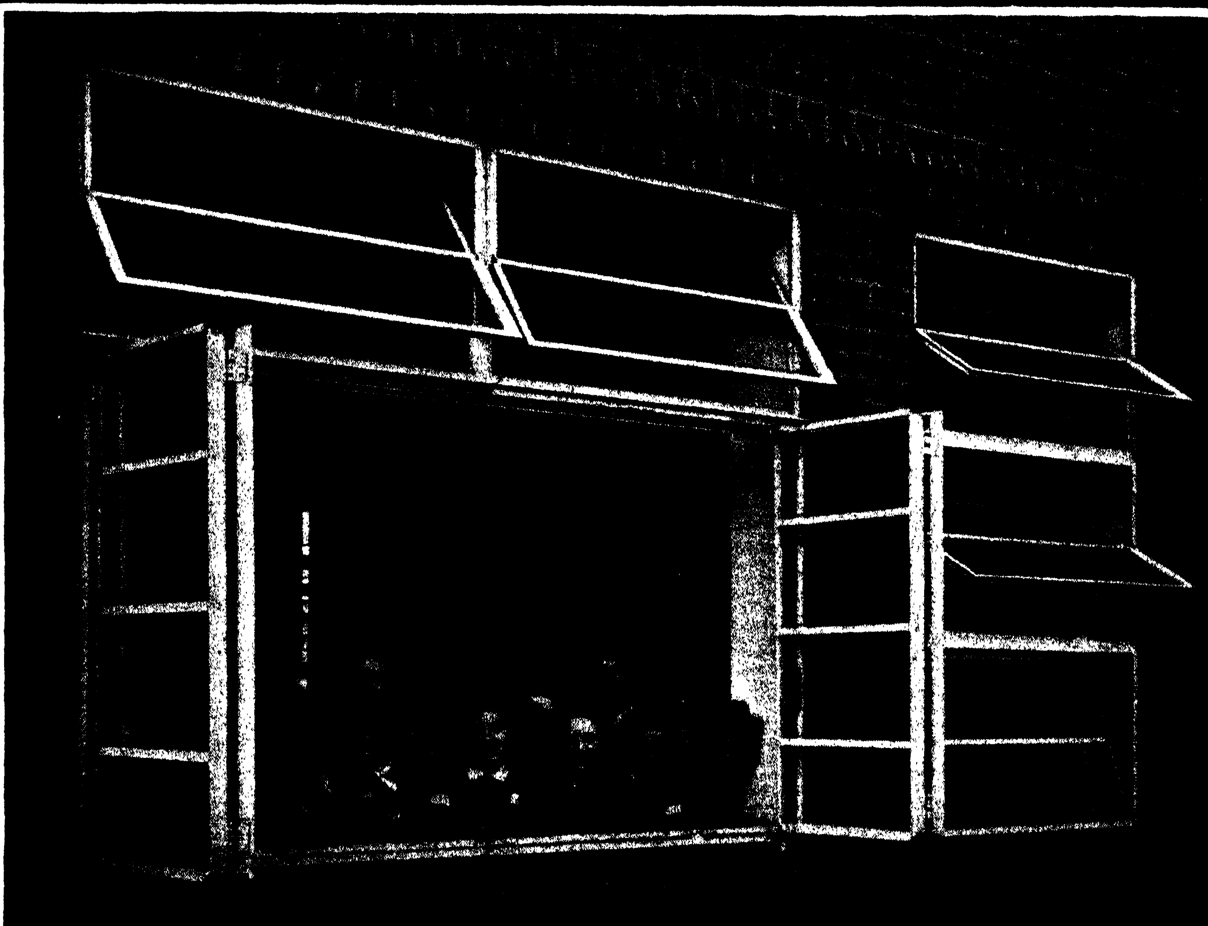

Classified Index

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CLASSIFIED INDEX—*continued*

CLASSIFIED INDEX—*continued*

CLASSIFIED INDEX—*continued.*

CLASSIFIED INDEX—*continued*

CLASSIFIED INDEX—*continued.*

ASCOT INSTANTANEOUS GAS WATER HEATER:

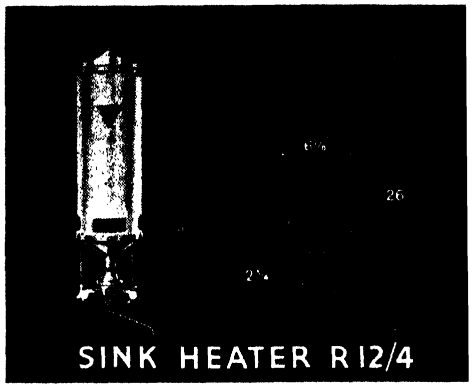
SINK HEATER

Type R 12/4 Instantaneous Sink Gas Water Heater, installed on main supply, provides hot water at temperatures up to 100° F. above cold suitable for drinking and culinary purposes. An automatic valve is fitted ; it is designed to prevent the passage of gas to the burner unless a pre-determined flow of water is passing through the heater. A safety device is incorporated to ensure that no gas can pass to the burner if the pilot light is extinguished, even though the automatic valve be open.

OUTPUT.—500 B.Th.U. per minute or 0·5 gallons per minute raised through 100°F., or 1·25 gallons per minute raised through 40° F.

INPUT.—625 B.Th.U. per minute or 1·25 cu. ft. per minute (Calorific value of Gas 500 B.Th.U. per cu. ft.).

INSTALLATION DATA.—Cold water and gas connections : ½" male B.S.P. taper thread. Meter capacity : 80 cu. ft. per hour in addition to other requirements (calorific value 500 B.Th.U. per cu. ft.). Minimum head of water : 15–20 ft. (dependent upon length of run and number of bends in supply).



SINK HEATER R 12/4

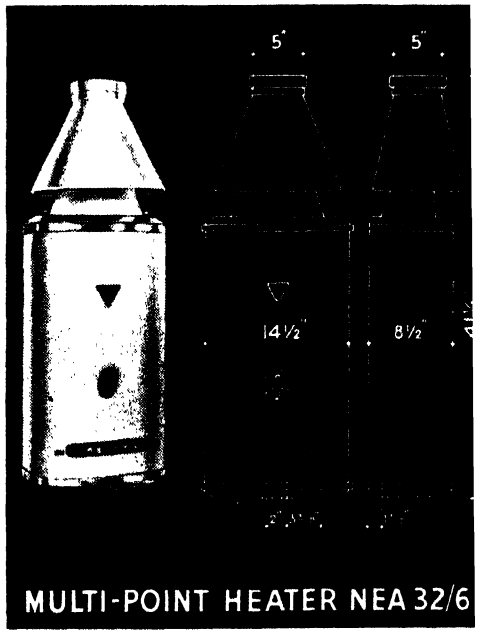
MULTI-POINT HEATER

Type NEA 32/6 Instantaneous Multi-point Gas Water Heater supplies bath, basin and kitchen sink, and may be connected to main or tank supply. A Summer/Winter temperature compensator ensures approximately the same maximum hot water temperature in both Winter and Summer. An automatic valve is fitted to prevent the possibility of gas passing to the burner until water is flowing through the heater. A draught diverter, designed to prevent adverse flue conditions interfering with combustion, is fitted as an integral part of the heater. The burner incorporates a safety device to ensure that no gas can pass if the pilot light is extinguished.

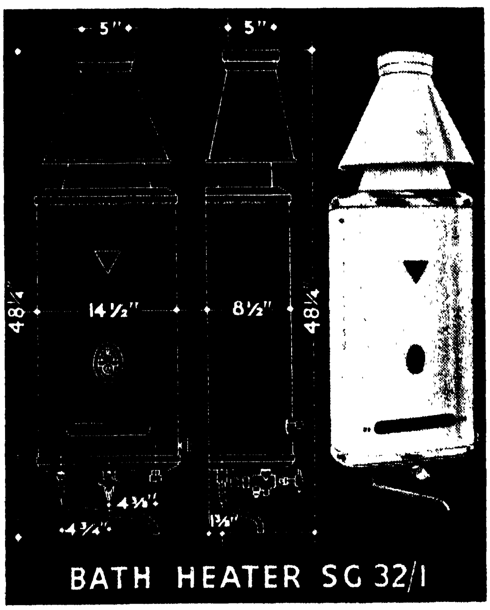
OUTPUT.—1,300 B.Th.U. per minute, or 1·3 gallons per minute raised through 100° F., or 2·6 gallons per minute raised through 50° F., or 3·25 gallons per minute raised through 40° F.

INPUT.— 1,625 B.Th.U. per minute, or 3·25 cu. ft. per minute (calorific value of gas 500 B.Th.U. per cu. ft.).

INSTALLATION DATA.—Gas connection : ¾" male B.S.P. taper thread. Hot and Cold water connections : ¾" male B.S.P. taper thread. Meter capacity: 200 cu. ft. per hour in addition to other requirements (calorific value 500 B.Th.U. per cu ft.). Minimum head of water : 10- 12 ft. (dependent upon length of run and number of bends in supply). Flue socket to take 5" internal diameter flue pipe.



MULTI-POINT HEATER NEA 32/6



BATH HEATER SG 32/1

BATH HEATER

Type SG 32/1 Instantaneous Bath Gas Water Heater with swivel spou provides hot water service to bath and adjacent basin, and may be connecte to main or tank supply. The automatic valve incorporates a Summer/Winte temperature compensator which ensures approximately the same maximun hot water temperature in both Winter and Summer. A draught diverter fitted as an integral part of the Heater, prevents adverse flue condition interfering with combustion, and a safety device fitted to the burner ensure that no gas can pass if the pilot light is extinguished.

OUTPUT.—1,300 B.Th.U. per minute, or 1·3 gallons per minute raised through 100° F., or 2·6 gallons per minute raised through 50° F., or 3·25 gallons per minute raised through 40° F.

INPUT.—1,625 B.Th.U. per minute, or 3·25 cu. ft. per minut (calorific value of gas 500 B.Th.U per cu. ft.).

INSTALLATION DATA.—Gas connection : ¾" male B.S.P. taper thread Cold water connection: ½" male B.S.P. taper thread. Meter capacity : 20(cu. ft. per hour in addition to other requirements (calorific value 500 B.Th.U per cu. ft.). Minimum head of water : 10–12 ft. (dependent upon length of rur and number of bends in supply). Flue socket to take 5" internal diameter flue pipe.

ASCOT GAS WATER HEATERS LIMITED • NEASDEN • LONDON

CLASSIFIED INDEX—*continued*

HOT WATER BY ELECTRICITY

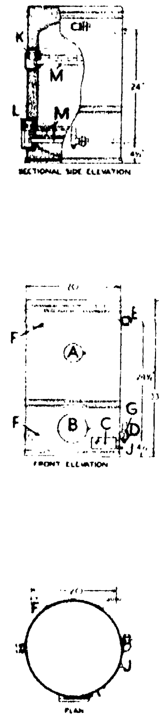
THE SADIA TYPE U.D.B.

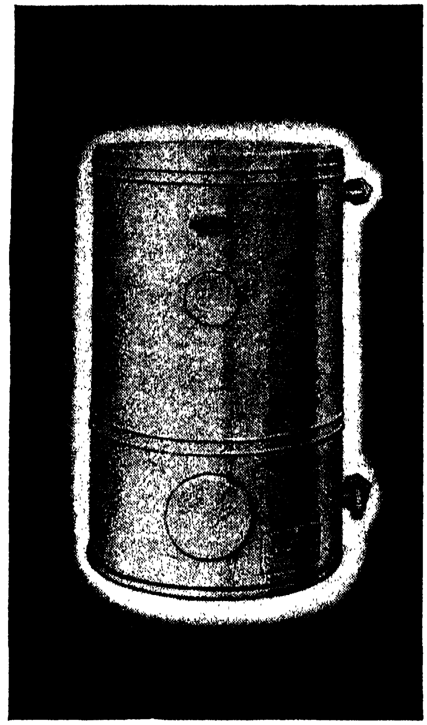
The Sadia Type U.D.B. is an entirely automatic storage water heater of 20 gallons capacity. Being fitted with two element plates, it is, in effect, two heaters in one. The small heater at the top is permanently connected to the current and ensures a regular supply of hot water at the sink and wash basin. A thermostat is fitted which controls the element automatically and prevents any waste of electricity.

The larger element at the bottom, is brought into operation by a foot press switch when baths or larger quantities of hot water are required.

This compact economical unit can be installed under the draining board in the kitchen and will provide hot water in both kitchen and bathrooms at a running cost within the means of the working man.

Numbers of public authorities have already adopted Sadia U.D.B.s for their rehousing programmes.





DIMENSIONS:

- A. Top heater (500 w.)
- B. Bottom heater (2,500 w.)
- C. Foot switch for bottom heater
- D. Inlet, ¾" B.S.P.T.
- E. Outlet, ¾" B.S.P.T.
- F. Bracket (optional)
- G. Drain cock
- J. Cable entry
- K. 5 amps. Aidastat
- L. 15 amps. Aidastat
- M. Heating elements

SMOKELESS · FUMELESS · ODOURLESS

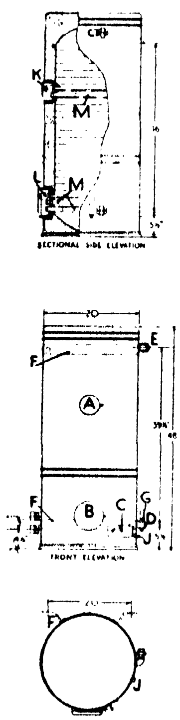
THE SADIA TYPE C.E.L.

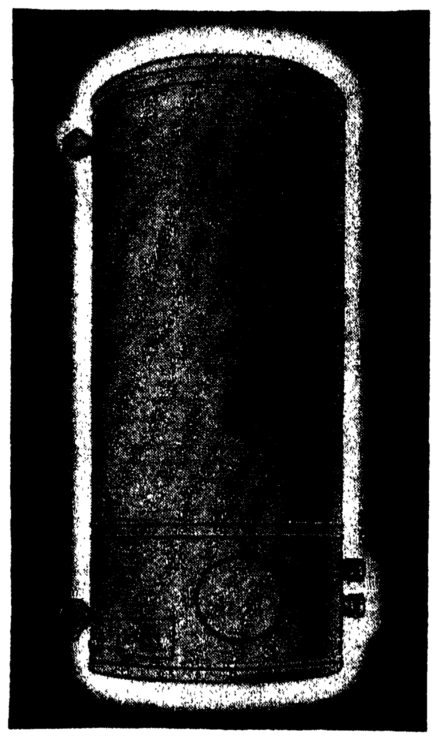
This is a Coal-Electric water heater. It works in a similar way to the U.D.B. with the additional advantage that it can automatically make full use of the heat from a kitchen or living room fire.

The C.E.L. has a capacity of 30 gallons and takes the place of the storage tank usually provided in a fired hot water system. It can be arranged for either wall or floor mounting.

For hard water districts an internal calorifier is fitted to obviate fur deposits in the boiler.

During winter months when fires are in use running costs are naturally very low indeed. When the fire is out, the hot water service continues automatically. The C.E.L. thus combines the best features of both electric and fired hot water services.





DIMENSIONS:

- A. Top heater (500 w.)
- B. Bottom heater (2,500 w.)
- C. Foot switch for bottom heater.
- D. Inlet, ¾" B.S.P.T.
- E. Outlet, ¾" B.S.P.T.
- F. Bracket (optional)
- G. Drain cock
- H. Flow, 1" B.S.P.T.
- I. Return, 1" B.S.P.T.
- J. Cable entry
- K. 5 amps. Aidastat
- L. 15 amps. Aidastat
- M. Heating elements

AIDAS ELECTRIC LIMITED, Sadia Works, Rowdell Road, Northolt, Middlesex, England. Phone: WAXlow 1607. Grams: Aidaselect, Greenford. ***Scottish Agents:*** **W. Brown & Co. (Engineers) Ltd., 89, Douglas Street, Glasgow, C.2**

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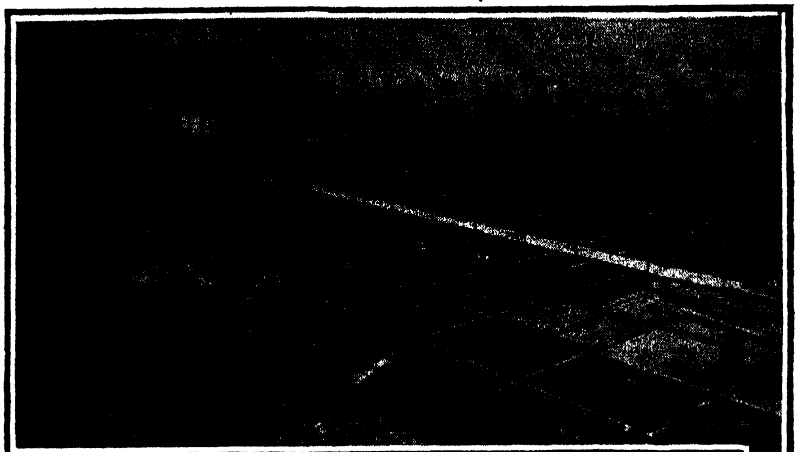

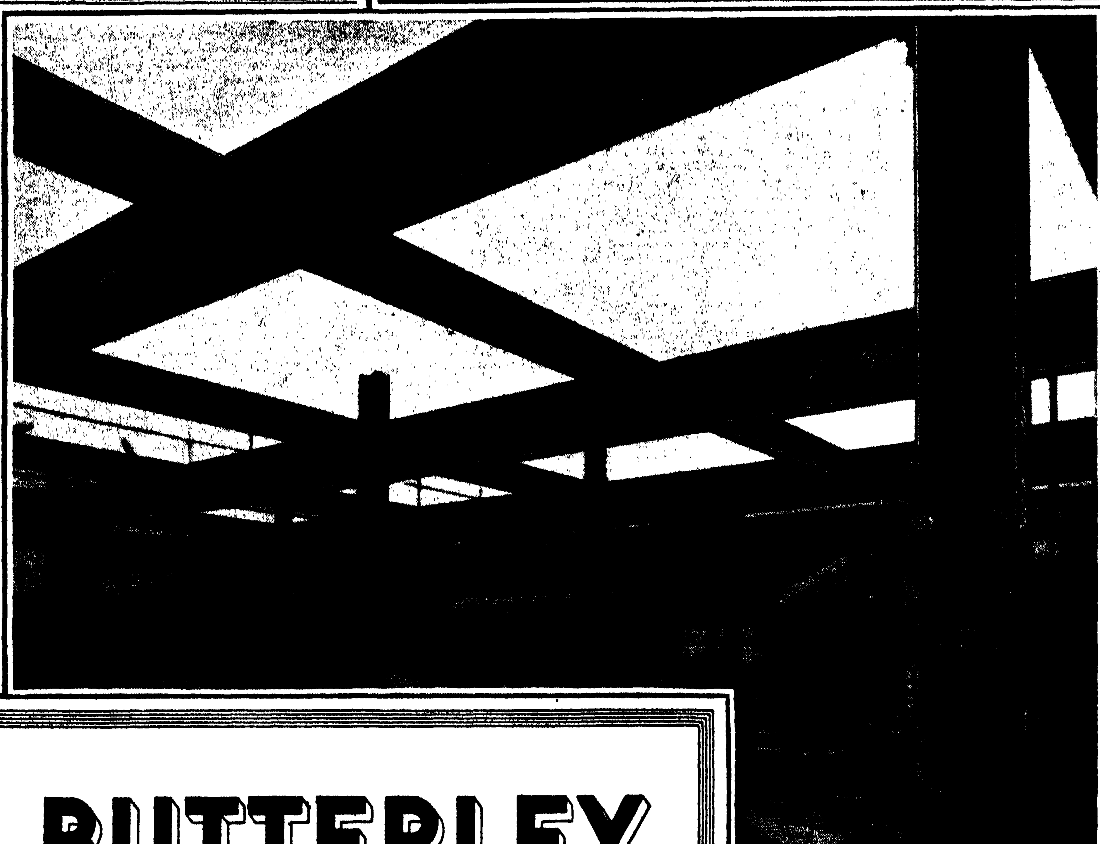

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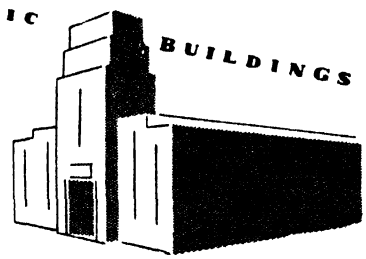
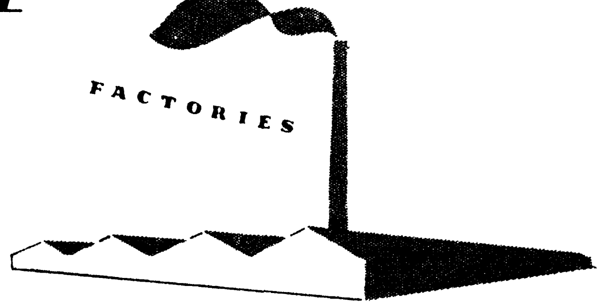
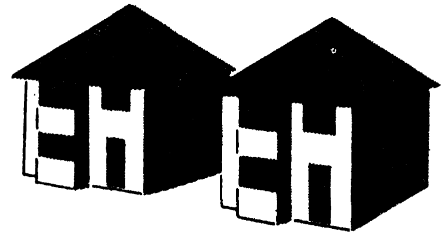


FACTORIES



HOUSES



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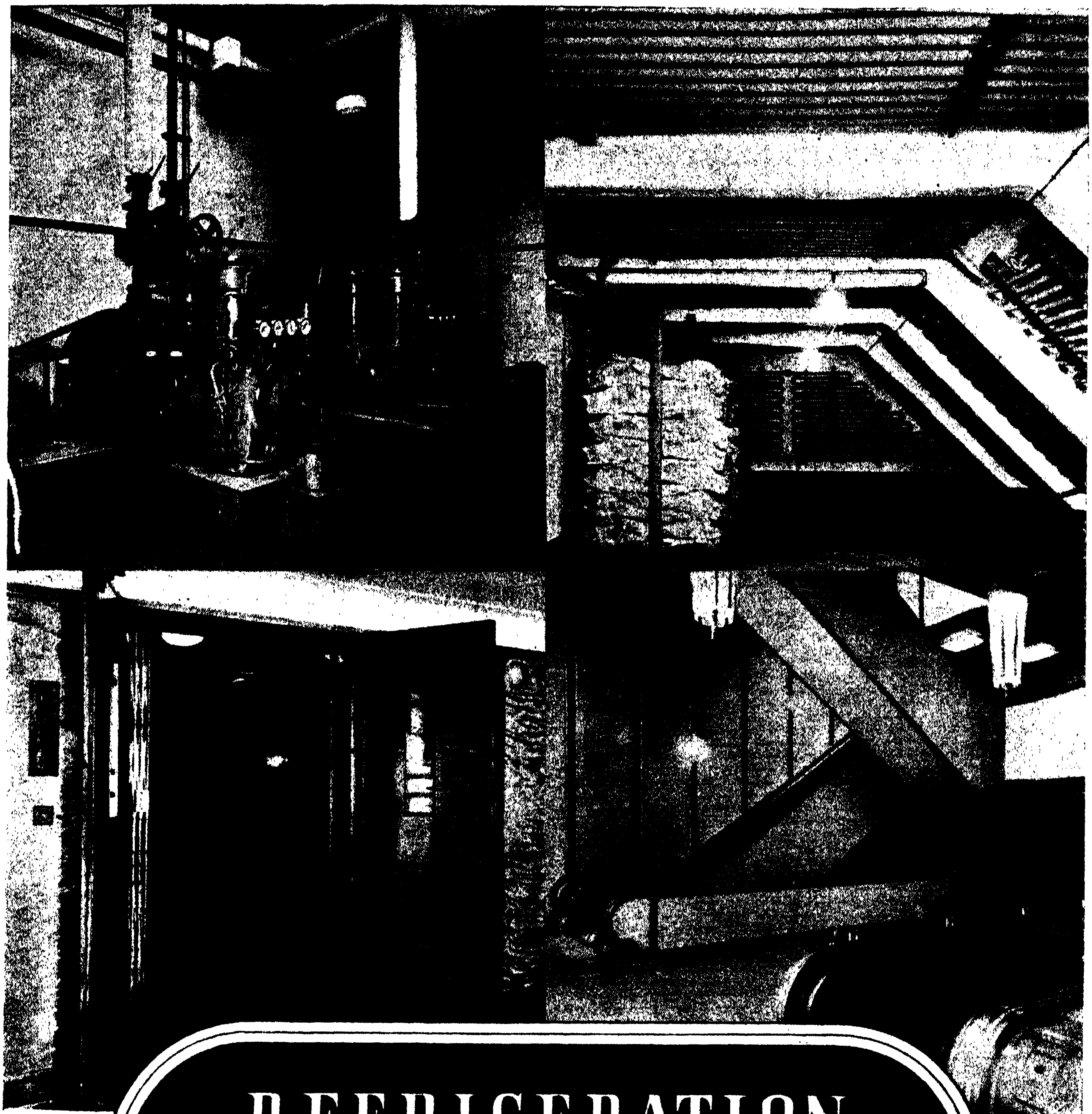

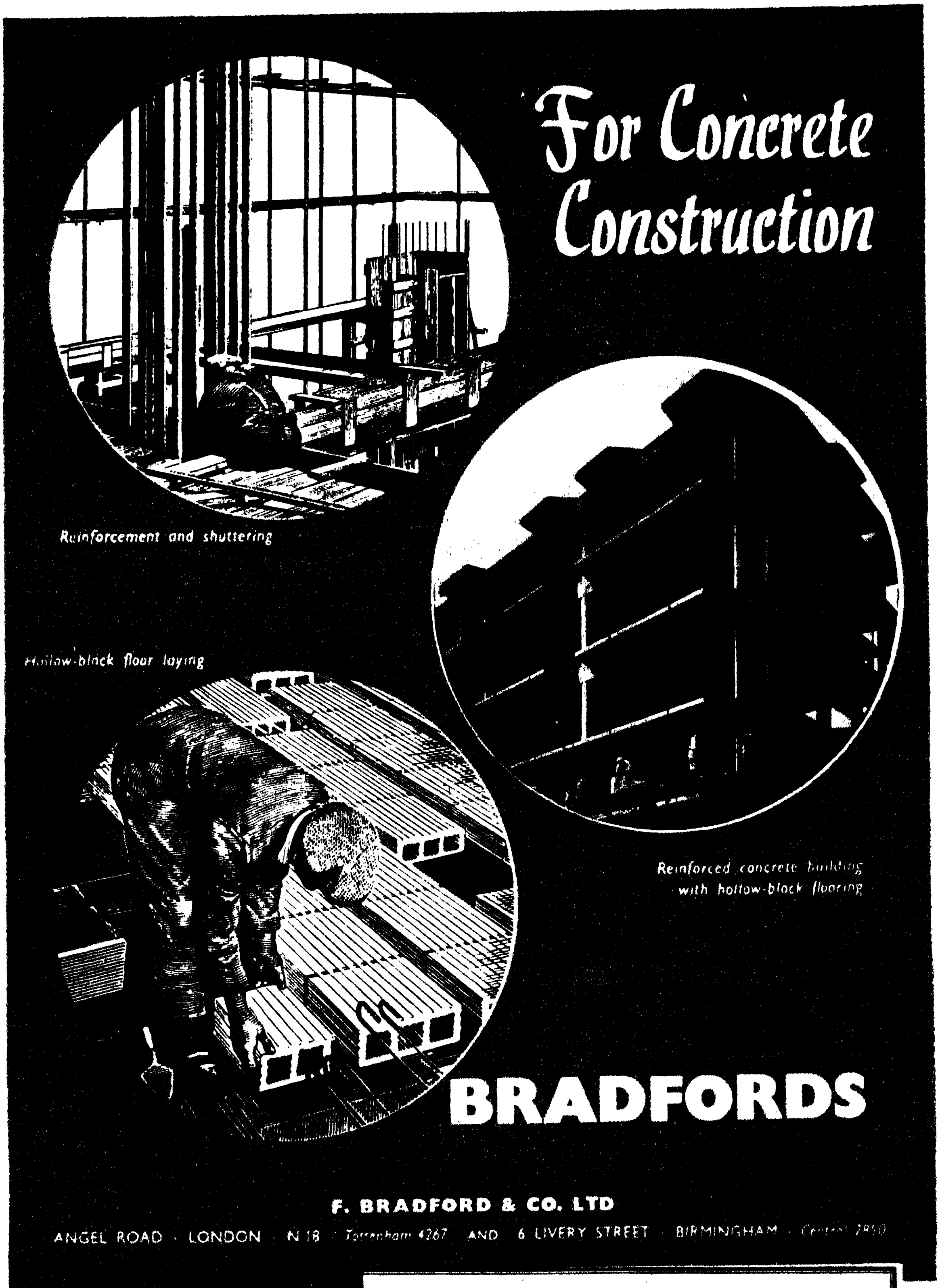

THE BRADFORD BARREL-VAULT ROOF

This roof consists of a thin reinforced-concrete shell stiffened by beams to carry usual loads over spans up to 200 feet. Advantages are economy in erection and upkeep, high resistance to fire and an unbroken interior surface which allows full lighting efficiency and permits no lodgement for dust.

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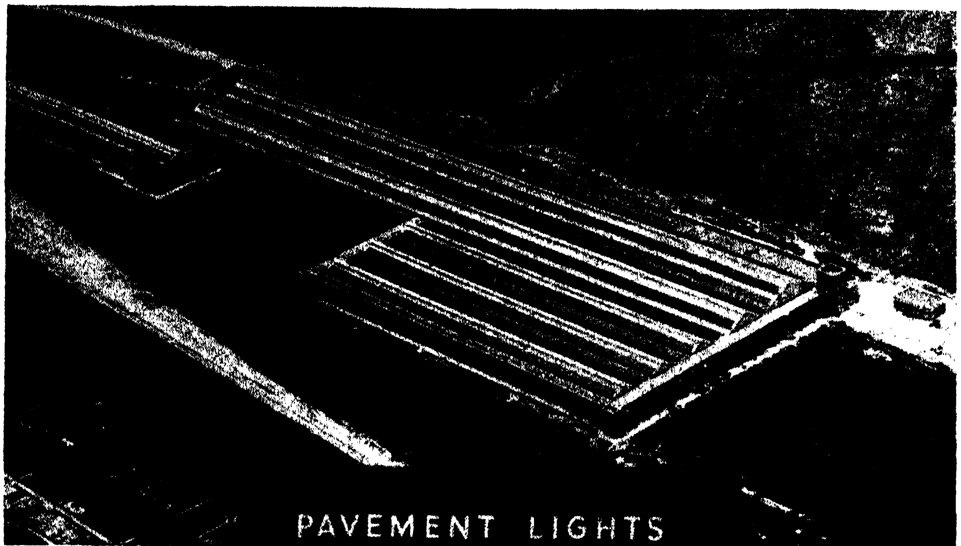

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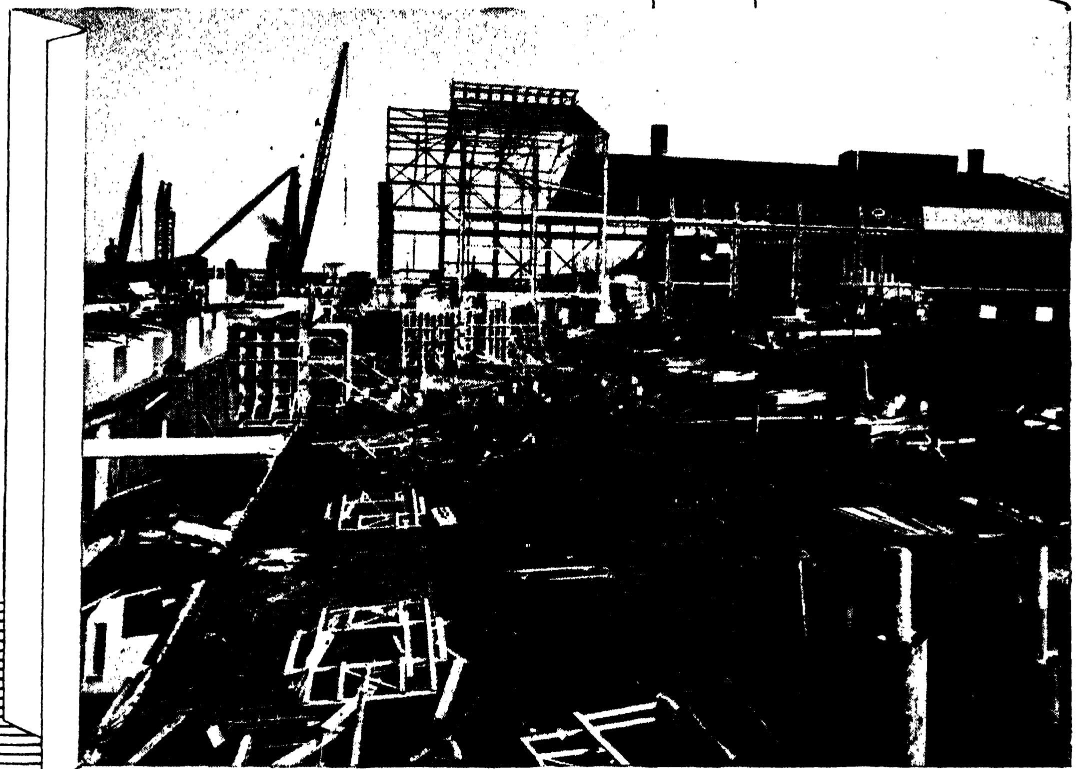

Consulting Engineer: Dr. Oscar Faber, O.B.E., M.I.C.E.
General view of steel rolling mill under construction.
Photo by courtesy of Messrs. John Summers & Sons Ltd.

This particular mill is situated in North West England. On its completion over 35,000 cubic yards of concrete had been laid. In addition nearly 2,000 tons of steel re-inforcing bars and 47,500 square feet of timber shuttering were used. We at Monks specialise in Major Constructional projects. Our war contracts alone totalled over £14,000,000 — a record of service which enables us to tackle post-war construction and re-construction with unequalled experience and efficiency. All enquiries receive the attention of experts.

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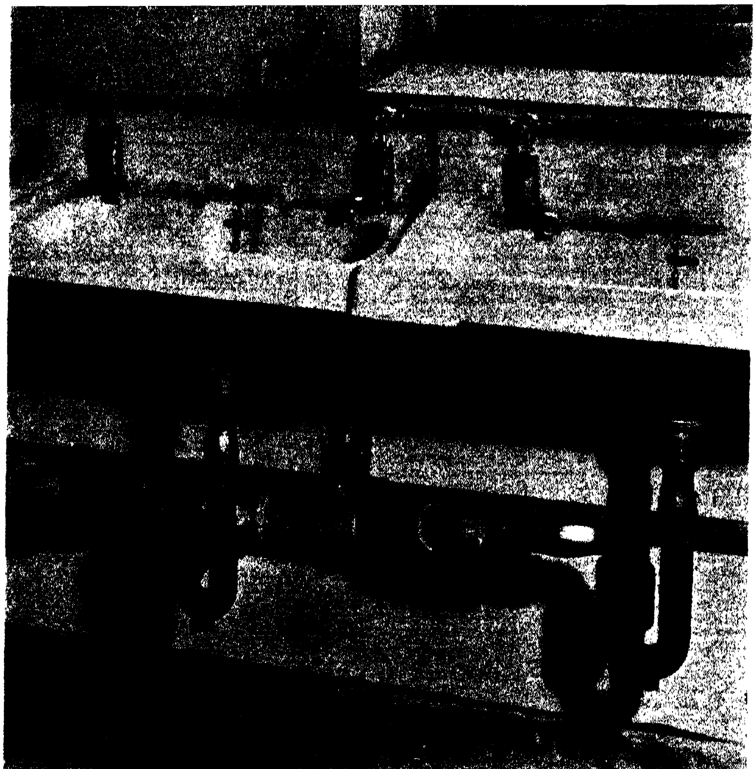
117-25

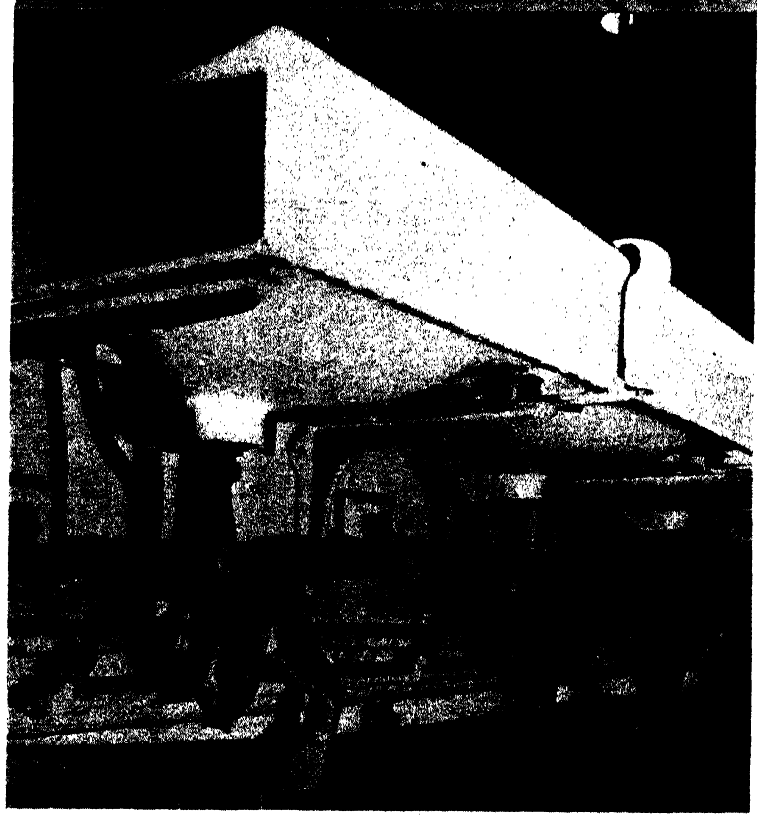
A COMPARISON BETWEEN McALPINE PATENT DRAWN LEAD RESEALING TRAP
(Patent No. 407,420)
AND THE ORDINARY TRAP



RESEALING TRAPS

This Photograph, taken before the front casing below the basins was fitted, shows a typical plumbing arrangement to a range of lavatory basins. It shows the simplicity of arrangement which is possible with Resealing Traps in contrast to the picture below.

It is absolutely essential to see that our Pat. No. 407,420 is stamped on all Resealing Traps without which none are genuine. These Traps are also made in Brass 1¼" and 1½" diameters "S" and "P" types.



ORDINARY TRAPS

This photograph shows a similar installation to that above, but in which ordinary traps have been used, with the consequent complication of vents to each trap. The labour and material required is considerably greater than in the case shown above.

Complete data published in booklet "RESEALING LEAD TRAPS," sent on request from

McALPINE & CO. LIMITED

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SOLE PATENTEES OF THE McALPINE HYDRAULIC DRAWN LEAD RESEALING TRAPS

A L U M I N E X

ALUMINEX

A special alloy of aluminium, silicon and magnesium is used for Aluminex glazing bars and fittings to obtain the maximum strength with a high resistance to corrosion.. It has been shown that the composition of the alloy used in aluminium work is a more important factor in resisting corrosion than any of the usual forms of coating such as anodizing or lacquering.

DURABILITY

Whilst the use of aluminium for roof glazing has now to its credit more than a decade of successful development by Williams & Williams Ltd., aluminium itself has been used in building work for half a century. Examples of aluminium work exposed to the weather for 50 years and more in this country, America and the Continent prove that aluminium is a highly satisfactory material for architectural work. In practice, a fine film forms over the surface of all exposed aluminium work in a relatively short time, and thereafter this film completely protects the metal.

MAINTENANCE

Aluminex roof glazing requires no protection and no maintenance, either externally or internally. No initial or subsequent painting is required.

GUARANTEE

The Aluminex Bar carries an identical guarantee to that which accompanies the use of all well-known systems of Patent Glazing.

ALUMINEX STANDARD SECTIONS

Aluminex glazing bars are produced in standard sizes designed for spans up to 10 ft. 8 in. Each section includes a main web with ribs on each side to hold the continuous cover strip in place; ribs to serve as anti-capillary stops for the glass, supporting flanges to receive the weight of the glass and further flanges to form drainage and condensation channels.

The design of the continuous cover strip is based upon the direction of the various forces and their reactions, so that it holds the glass firmly in place yet is sufficiently resilient to absorb shocks and vibration and to permit thermal movements. The cover

R O O F G L A Z I N G

strip requires no screws, clips or other fixings to hold it permanently in place. Experience in large areas of executed work has shown that the bar and cover strips are completely weatherproof without secondary safeguards such as cord seatings or flashings.

SPACING OF BARS

The recommended spacing for Aluminex bars is 2 ft. ½ in., and the safe spans for the three types of bars shewn on Page 4 have been calculated on this spacing. They may, however, be used at a greater spacing with a corresponding reduction in safe span, subject only to the strength of the glass. With ¼ in. rolled glass (Rough Cast or Georgian wired) it is recommended that the spacing should not exceed 2 ft. 3 in.

PATENTS

Aluminex roof glazing sections are covered by British Patents Nos. 469887, 477880, 500623, 501417 and 510449, and additional patents are pending throughout the world. The sole manufacturers and Patentees are Williams & Williams Limited, Reliance Works, Chester.

GLASS STOPS

Specially designed patent fittings used at the foot of each Aluminex glazing bar to receive the foot, provide a fixing and serve as a glass stop.

Similarly, upper shoes are provided for fixing the upper end of the bars. Shoes are made in two types for fixing either to wood or steel construction.

FLASHINGS

Where Aluminex roof glazing abuts against vertical walls, either at the top of the slope or at the ends, flashings are used in the usual way.

A L U M I N E X

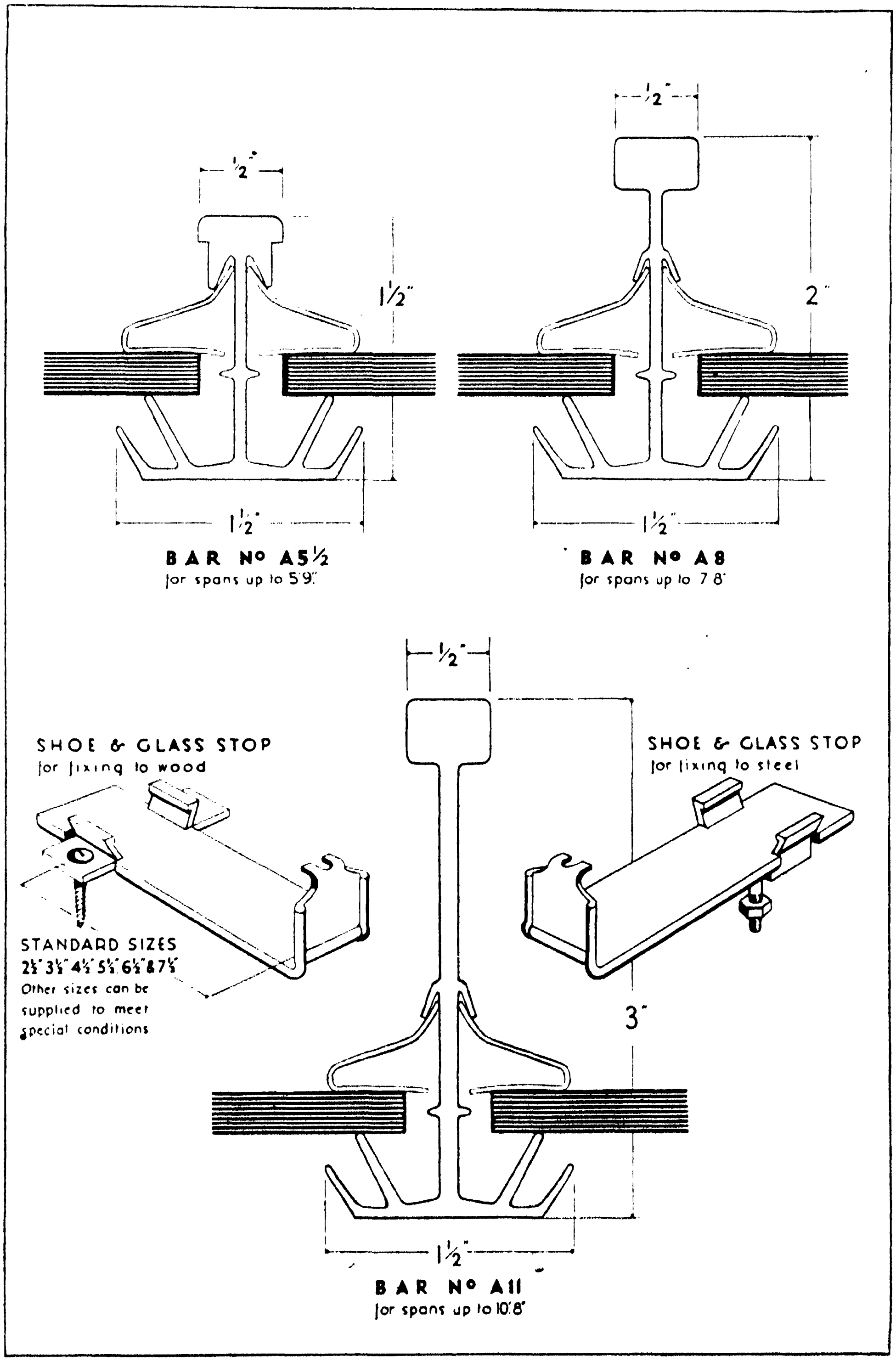
Illustrated below are three types of Aluminex glazing bars with the glass and continuous cover strips in position. Different sections of bars can be supplied to suit varying spans. The accurate design of the cover strips, with the three-point bearing they obtain, ensures that the glass is firmly yet flexibly held in position, while the end shoes and glass stops provide a secure fixing for the glazing bar.

STANDARD BARS, SHOES AND GLASS STOPS

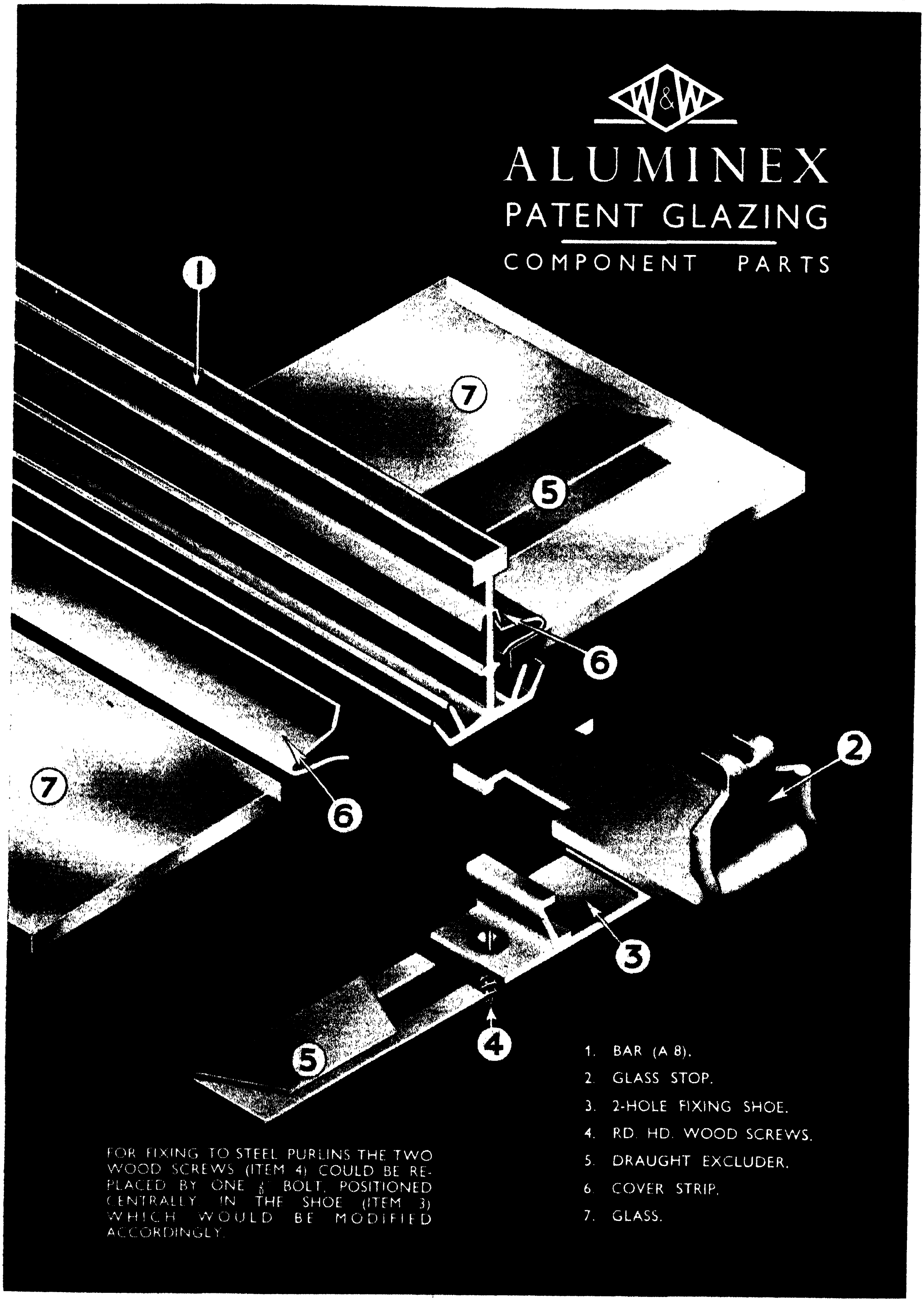
PATENTED THROUGHOUT THE WORLD

GLAZING BARS SHOWN FULL SIZE

SHOES & GLASS STOPS NOT TO SCALE



ROOF GLAZING

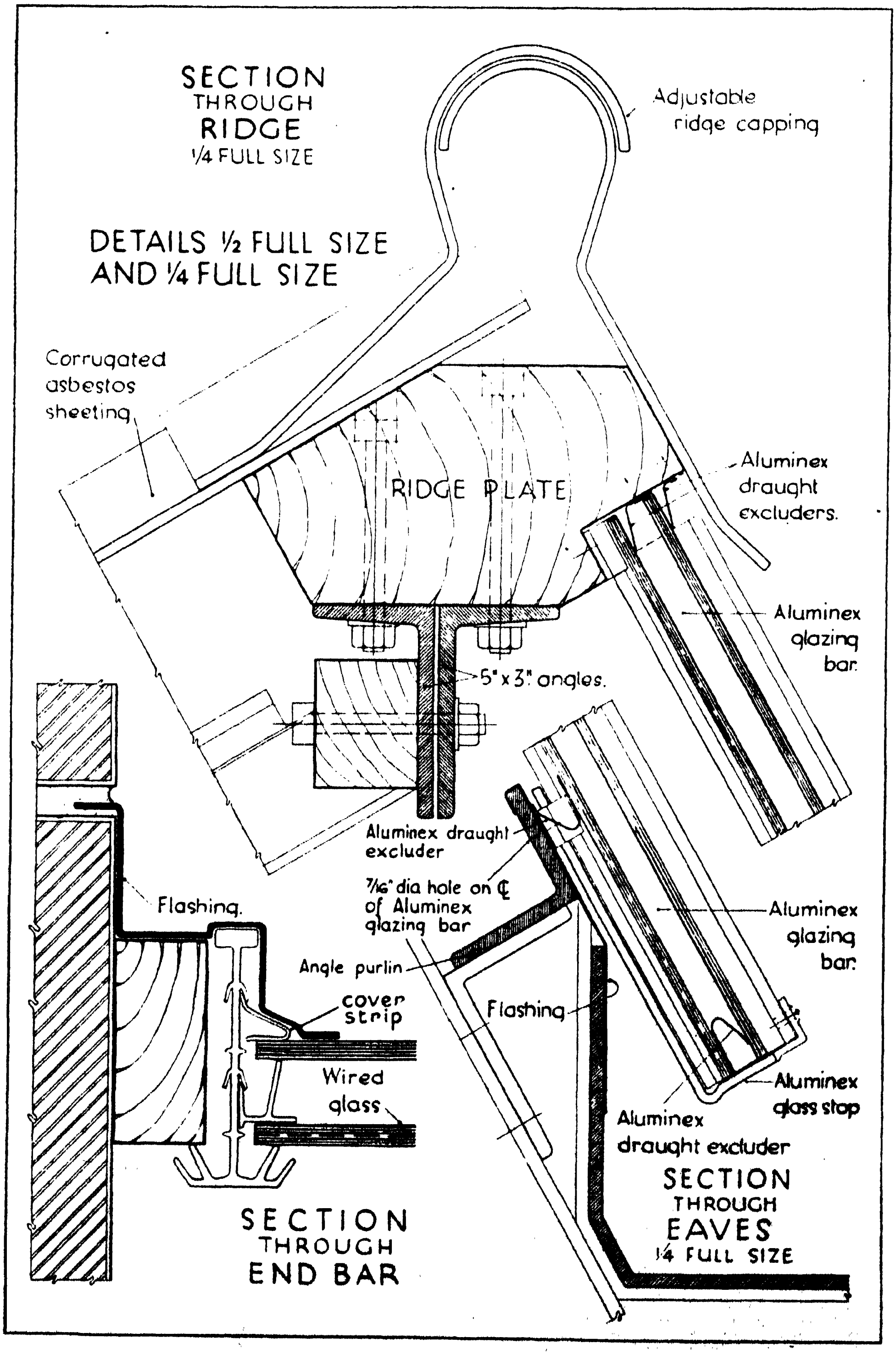


A L U M I N E X

The photograph shows the inner pane of glass being placed in position. An Aluminex draught excluder at the ridge is also shown being fixed. The provision of these excluders, in conjunction with the adjustable capping shown below, renders lead flashing unnecessary at the ridge.

The bar illustrated is for 8ft. 6in. spans, while a further section is available for 12ft. 2in. spans.

DOUBLE ROOF GLAZING



ROOF GLAZING

Bolton Municipal Technical College

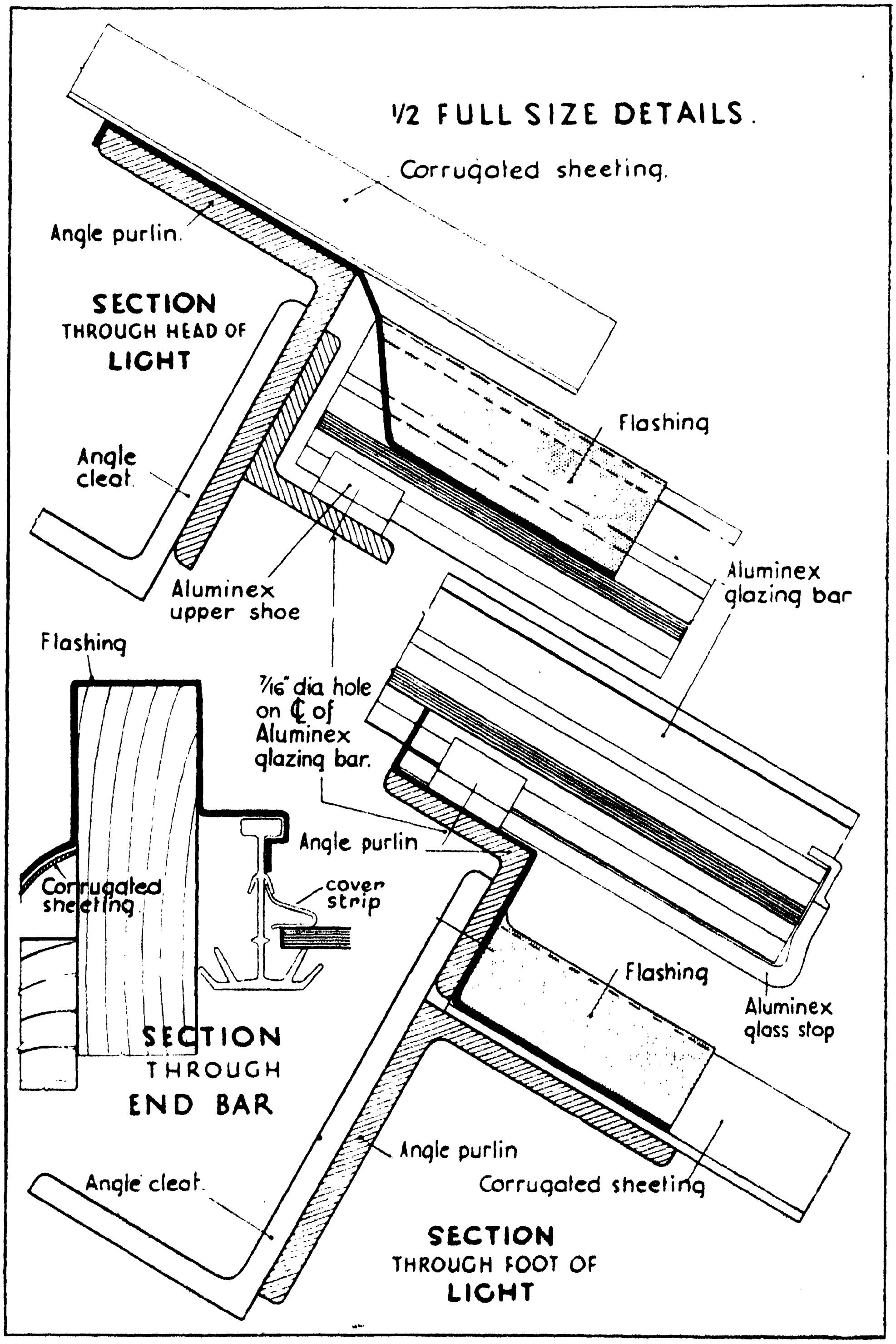
Architects: Lanchester, Lodge & Davis, F.F.R.I.B.A.

Contractors: Tarran Industries Ltd., Hull.

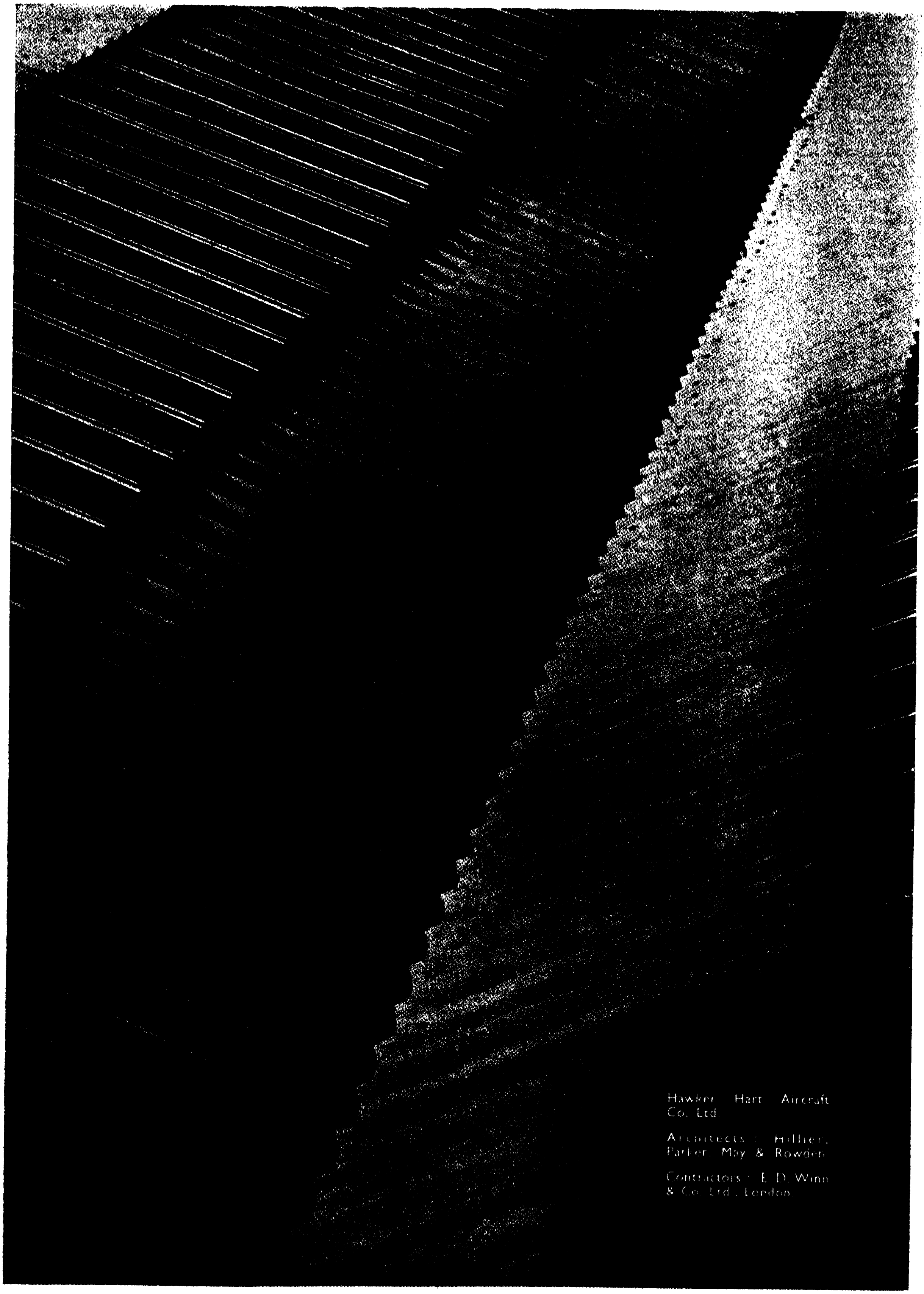
A L U M I N E X

No special construction is required for Aluminex roof glazing in corrugated sheeted roofs. In the example illustrated a continuous bearing was provided by two steel angles, to receive the top and bottom ends of the glazing bars. The shoes were then fixed directly to the flanges of the angles with one bolt to each shoe.

SKYLIGHT IN CORRUGATED SHEETING



ROOF GLAZING



Hawker Hart Aircraft Co. Ltd.

Architects: Hillier, Parker, May & Rowden.

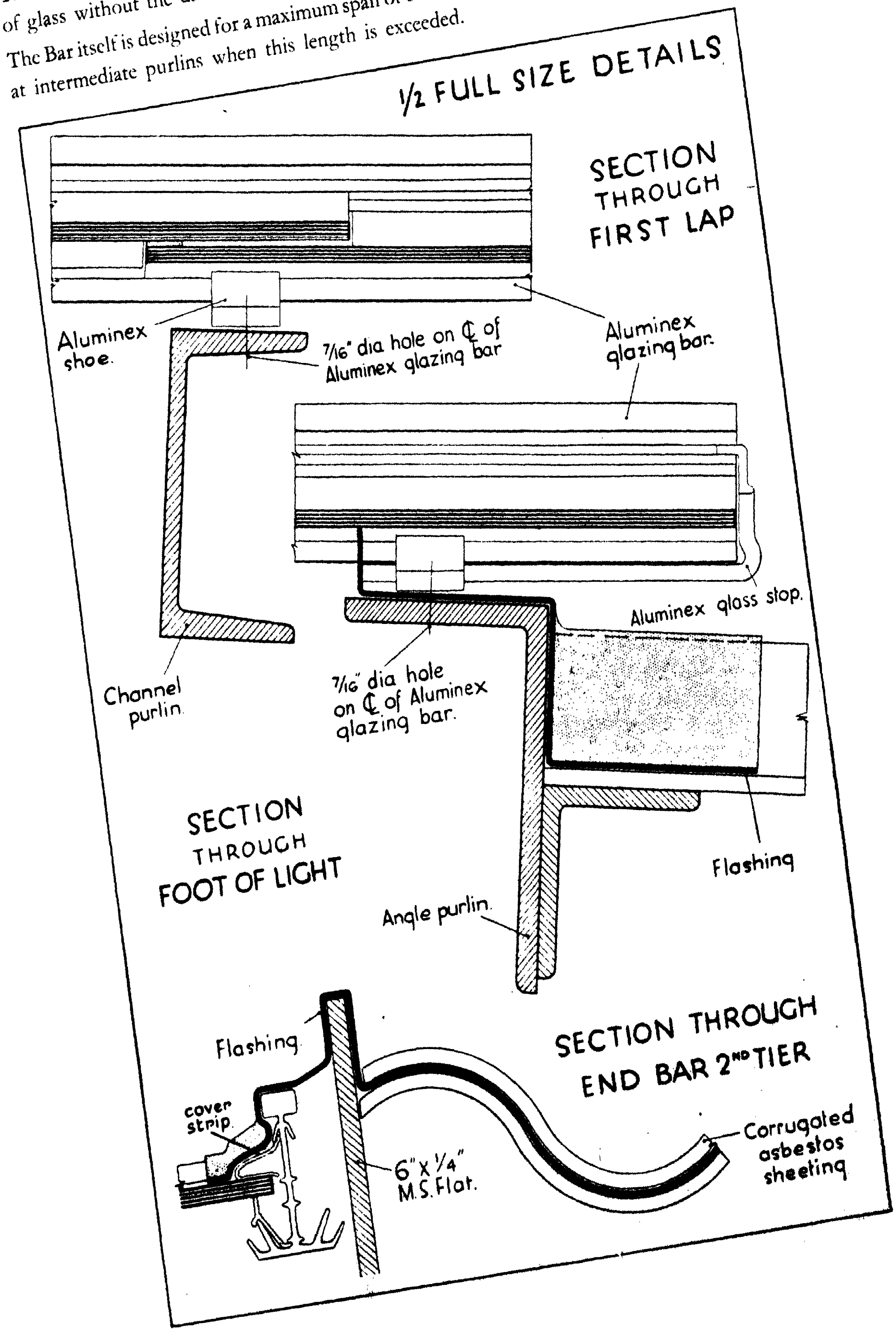
Contractors: E. D. Winn & Co. Ltd., London.

ALUMINEX

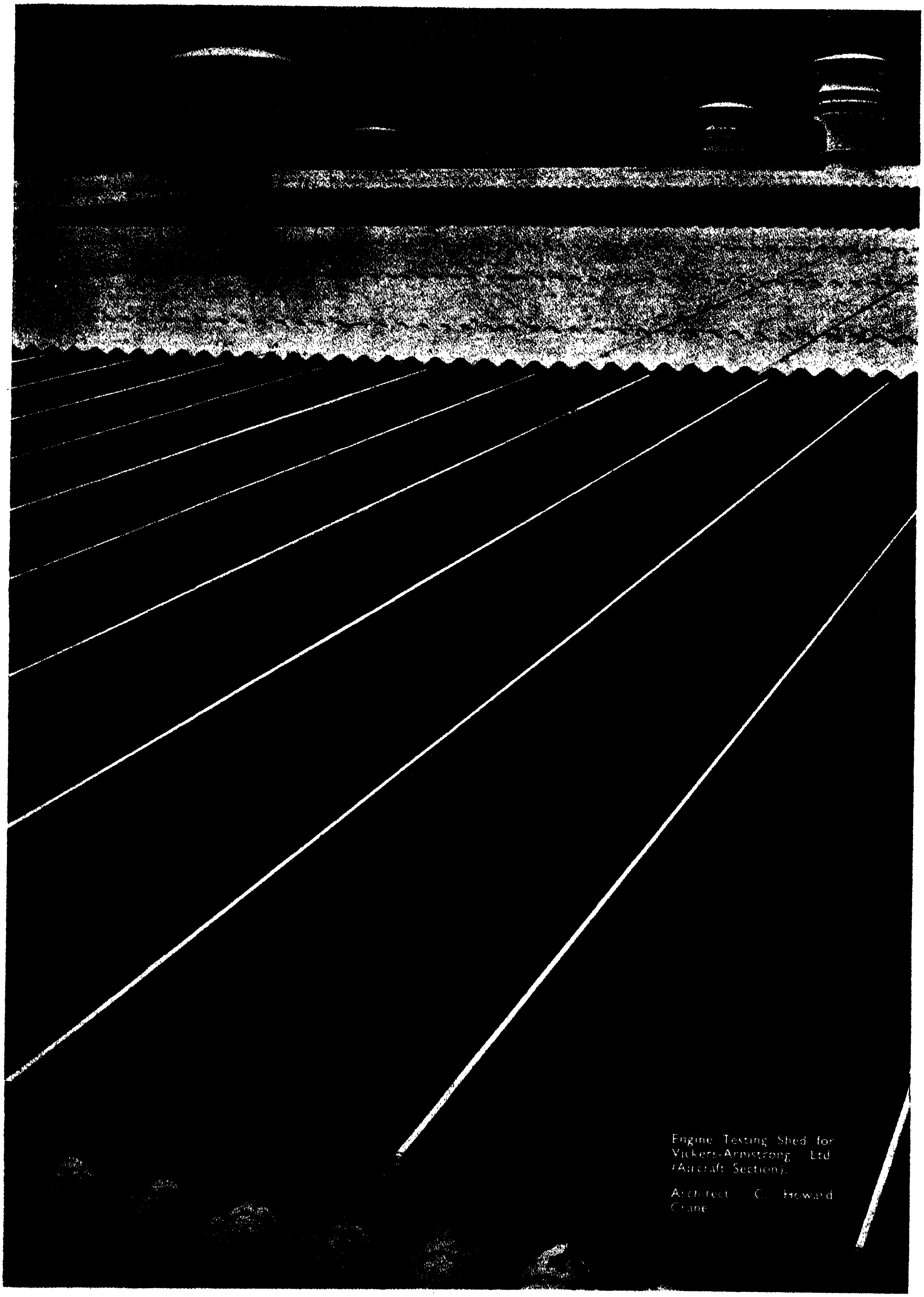
LAPPED ROOF GLAZING

The Aluminex Lapped Glazing Bar is designed to accommodate two or three tiers of glass without the use of lead flashing at the overlaps.

The Bar itself is designed for a maximum span of 8 feet and therefore requires supporting at intermediate purlins when this length is exceeded.



R O O F   G L A Z I N G



Engine Testing Shed for Vickers-Armstrong Ltd (Aircraft Section).

Architect C. Howard Crane

A L U M I N E X

ALUMINEX ROOF GLAZING

Opening lights in Aluminex roof glazing are provided with a continuous hinge of special design which is in itself completely waterproof; the flashing is usually carried up and over the hinge to ensure a waterproof joint with adjoining roofing material. Opening lights may be provided with either individually operated cord control opening devices or with multiple opening tension rod gear.

South-West Technical College, Walthamstow (Essex County Council).

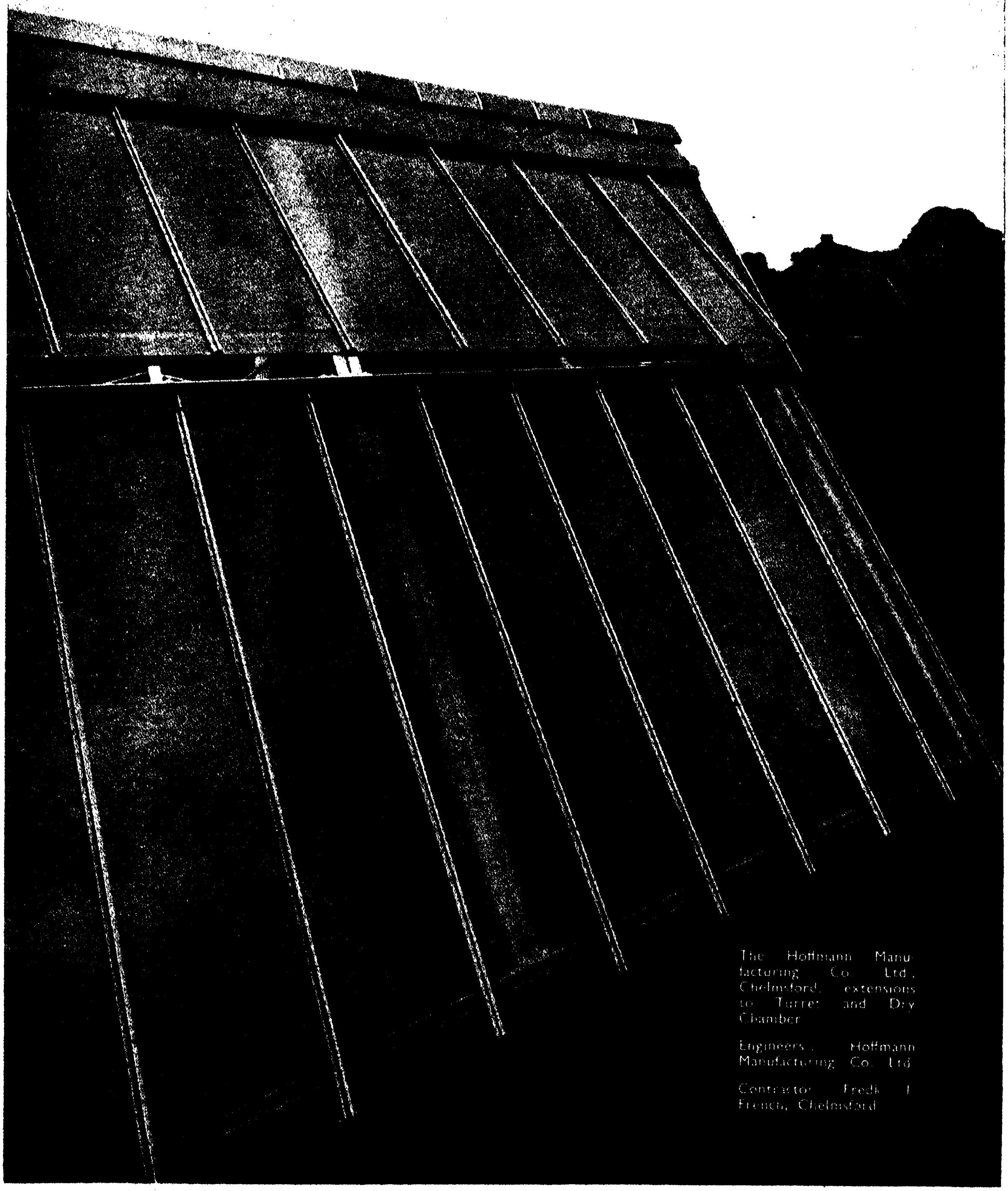
Architect: J. Stuart, F.R.I.B.A., County Architect, Chelmsford

Contractors: F. R. Hipperson & Son Ltd., London.

ROOF GLAZING

NORTH LIGHT ROOF GLAZING WITH CONTINUOUS OPENING LIGHTS and TENSION ROD GEAR

Continuously hinged opening lights can be operated in banks of almost any number by using tension rod gear, operated with a hand chain. The opening lights shown in the photograph form one continuous opening, but almost any number of separate lights may be operated in the same way by connecting them to the one operating rod.



The Hoffmann Manufacturing Co. Ltd., Chelmsford, extensions to Turret and Dry Chamber

Engineers : Hoffmann Manufacturing Co. Ltd.

Contractor : Fredk. J. French, Chelmsford

A L U M I N E X

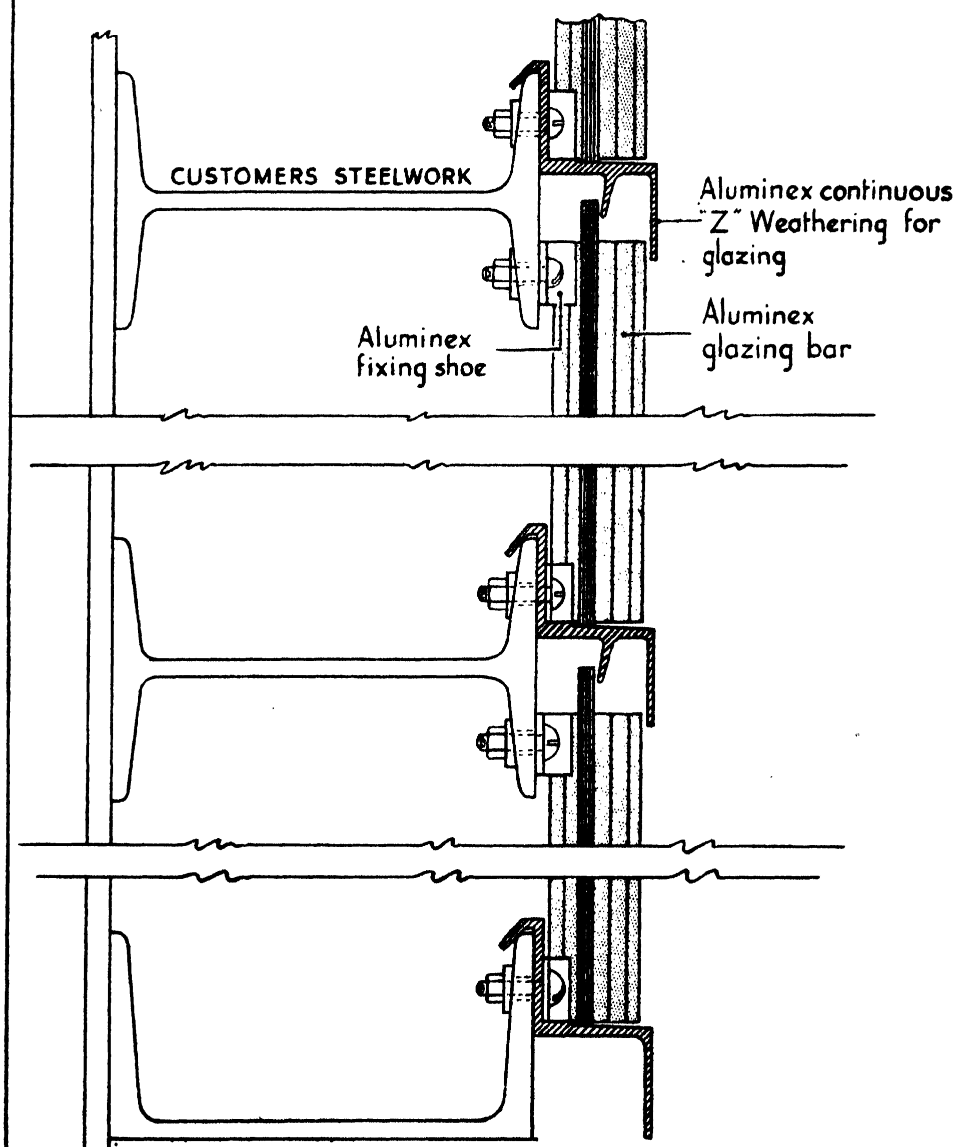
Experience gives dexterity to the craftsman and distinction to design. Nearly 100 years experience is embodied in

ALUMINEX SIDE WALL GLAZING

"IT WILL STILL BE MODERN IN 100 YEARS TIME."

Typical cross-section through FULLY GLAZED SIDE WALL

TYPICAL VERTICAL CROSS SECTION THROUGH FULLY GLAZED SIDE WALL



Aluminex continuous "Z" weathering is designed for side wall glazing using Aluminex glazing bars. The typical details shewn are for a side wall approximately 50 feet high in 5 foot tiers, extending horizontally in panes 3 feet 6 inches wide.

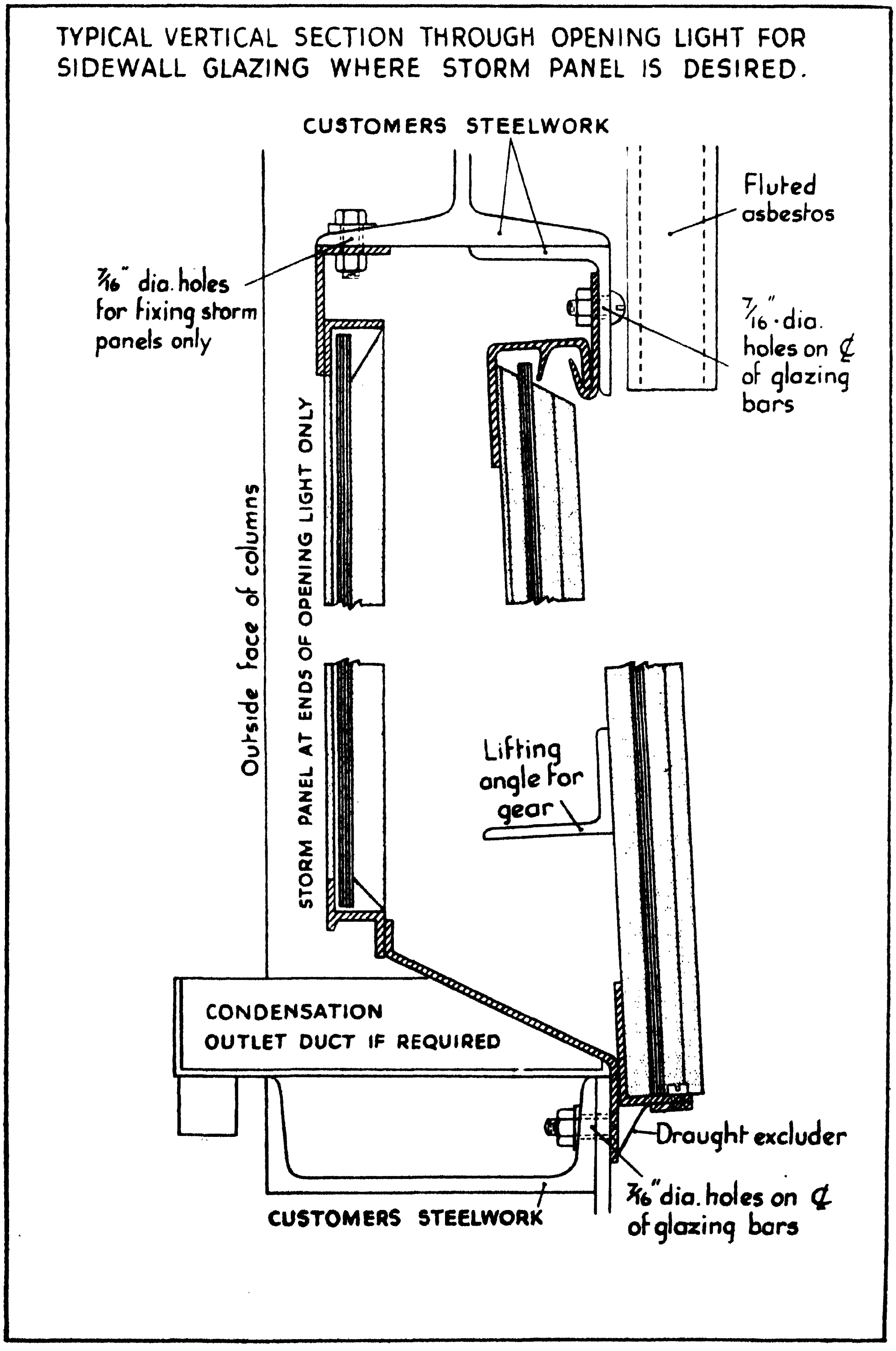
For larger pane areas stronger bars are provided.

SIDE WALL GLAZING

Adaptable to most types of wall construction

ALUMINEX SIDE WALL GLAZING

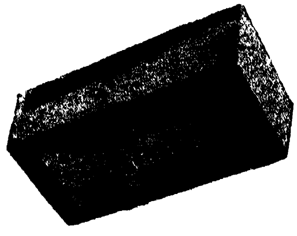
Provides for a continuous glazed wall with or without opening portions. It especially lends itself to modern developments in factory buildings.



Typical section of OPENING LIGHT for SIDEWALL GLAZING

"PHORPRES" BRICKS & HOLLOW CLAY BLOCKS

"PHORPRES" COMMON BRICK



The Standard common brick for general building purposes. Its wide use for industrial chimneys, bridges, foundations of big buildings and similar specialised work, offers adequate practical proof of its performance. Crushing strength 4590-lbs. per sq. in. (B.R.S. tests quoted page 108 in "Principles of Modern Building," D.S.I.R.) Cube foot weight of "Phorpres" brickwork 1·3 cement mortar = 106 lbs.; 1·3 lime mortar = 103 lbs. Sizes made 2", 2⅝" and nominal 3" (B.S.S.). The Company's process permits the manufacture of almost any special shape of brick. Details of stock specials will be supplied on application.

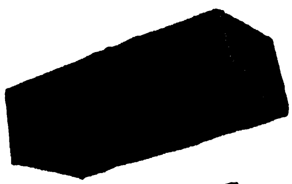
"PHORPRES" KEYED BRICK

This brick is made with dovetail keys on one stretcher face and one header face to provide a mechanical bond with plaster or stucco, thus reinforcing the normal suction bond developed during the setting. Types and sizes made: Standard 2", 2⅝", 3" (B.S.S.). Cellular 2⅝", 3" (B.S.S.).

"PHORPRES" CELLULAR BRICK

A brick designed to overcome a defect of most building materials — excessive weight in relation to required strength. Cube foot weight of cellular brickwork, 1·3 cement mortar = 82 lbs., 1·3 lime mortar = 79 lbs. The "Phorpres" Cellular brick is nearly 25 per cent. lighter in weight with adequate strength for all general building and gives improved insulation of heat and resistance to moisture. Types and sizes made: Plain, Keyed, Rustic, Sandfaced. 2⅝" and 3" (B.S.S.).

"PHORPRES" SANDFACED BRICK



A result of intensive experiment, this brick supplies the pleasant texture, colour and variations of tone of the hand-made sandfaced brick at a price only possible with highly mechanised production in large quantities. The "Phorpres" Sandfaced brick is supplied sandfaced upon one stretcher face and two header faces. Sizes made: 2", 2⅝" and 3" (B.S.S.). These bricks can be supplied in the "Phorpres" Cellular type of brick. Special shapes can also be supplied.

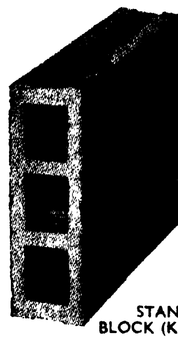
"PHORPRES" WHITE BRICK

This brick is made from the gault clay and is widely used for light-wells, areas, alleys and passages where a pleasant measure of light reflection is desired at a very slight additional cost over common bricks.
Sizes: 2⅝" and 3" (B.S.S.).

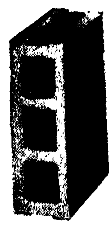
"PHORPRES" RUSTIC BRICK

Over one thousand million of these facing bricks have been used in housing, schools, and other Local Government building, and also, to specification, for larger, more costly examples of commercial and domestic construction. The 'Phorpres' Rustic Brick is supplied rusticated upon one stretcher face and one header face. Types and Sizes made:—Standard 2", 2⅝", 3" (B.S.S.). Cellular 2⅝", 3" (B.S.S.). Special shapes can also be supplied.

"PHORPRES" HOLLOW CLAY PARTITION BLOCKS. These adaptable building units for all types of partition work, internal linings to brickwork and partywall construction, are entirely inert and proof against shrinkage and cracking, thus ensuring sound plastering. They possess high compressive strength and can therefore be taken as load-bearing factors. Standard sizes are 12" × 8¾" × 2", 2½", 3" and 4½". Standard bonding lengths, Conduit and Fixing blocks are available in all thicknesses. Manufactured to comply with British Standard 1190:44, "Phorpres" partition blocks are supplied keyed or smooth face both sides and are computed at 12 blocks per yard.

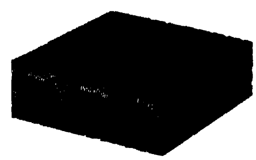


STANDARD BLOCK (KEYED TYPE)



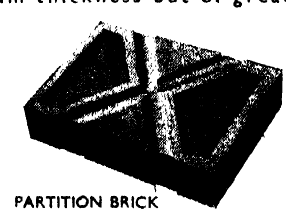
HALF BLOCK (SMOOTH FACE TYPE)

"PHORPRES" FLOOR BLOCKS AND FILLER TILES are manufactured to comply with BS. 1120:44 and the requirements of the leading local authorities for the construction of structural floors and roofs. The standard sizes are 12" × 12" and 12" × 10" made in the following depths: 3", 3½", 4", 4½", 5", 6", 7" and 8". The standard filler tile is made 12" × 3" × ⅝" and 12" × 4" × ⅝".



12" x 12" FLOOR BLOCK

"PHORPRES" GRIP PARTITION BRICKS. A form of partition brick, reinforced with galvanised steel wires which, whilst only 2" in thickness, provides partition walls of minimum thickness but of great strength and resistance to side pressure or vibration. Type and size made: 9" × 6½" × 2".



PARTITION BRICK

PHORPRES

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Selfstoke

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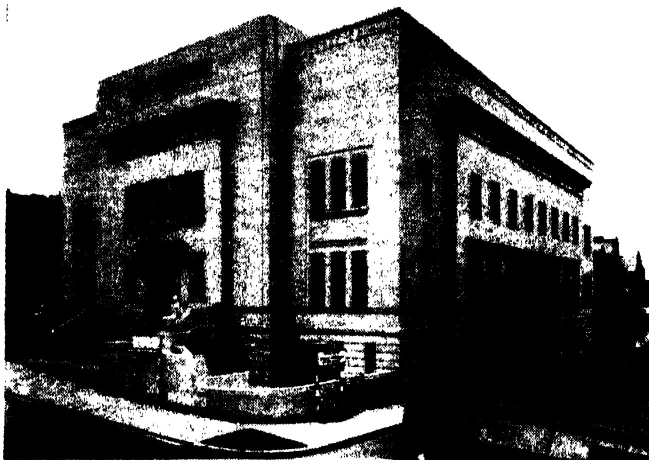
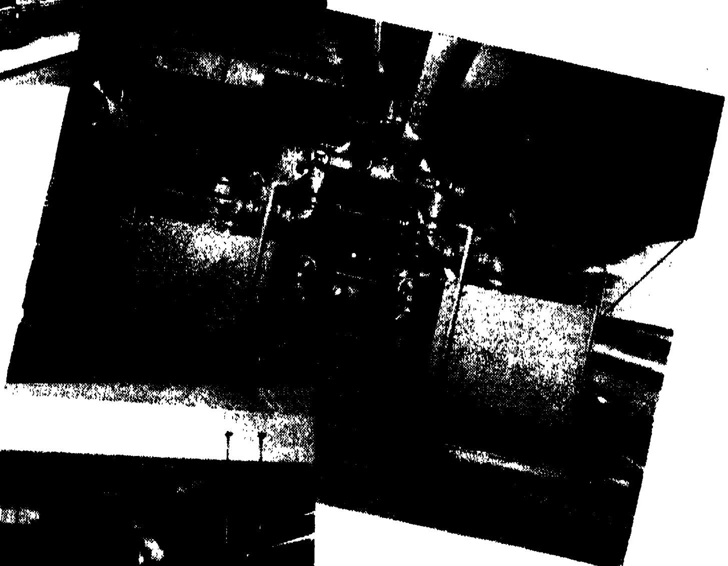


Huddersfield New Library. Heated by a battery of "Selfstoke" Boilers.

Architect :
E. H. Ashburner, B.Arch. A.R.I.B.A.



(Above and Left)—Boiler House at Huddersfield New Library illustrating the compact and efficient boiler installations.

Gravity Feed never fails, and Thermostatic Control, combined with the highest degree of Thermal Efficiency, gives a fuel saving 40% average over hand-fired plants of equal rating.

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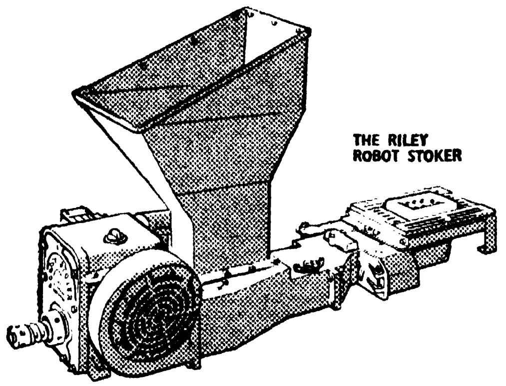
'Yes, it's comfort that counts'

says O'Riley, 'and that means <u>*Controlled Heat'*</u>



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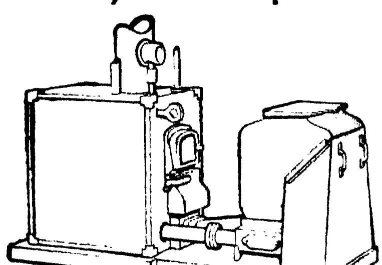
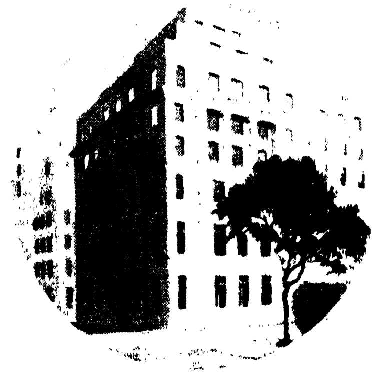


THE BABY ROBOT STOKER
attached to a domestic Boiler

FOR FLATS BLOCKS OFFICES LARGE BUILDINGS ★ FOR TOWN & COUNTRY HOUSES



The Riley Robot Stoker is the foremost mechanical stoker for central heating and hot water boilers in large buildings. It burns low-grade fuel with high efficiency, meets fluctuating loads with ease. Ten sizes for various ratings up to 2,700,000 B.Th.U's.

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Fully illustrated literature dealing with these stokers will be gladly sent on request.

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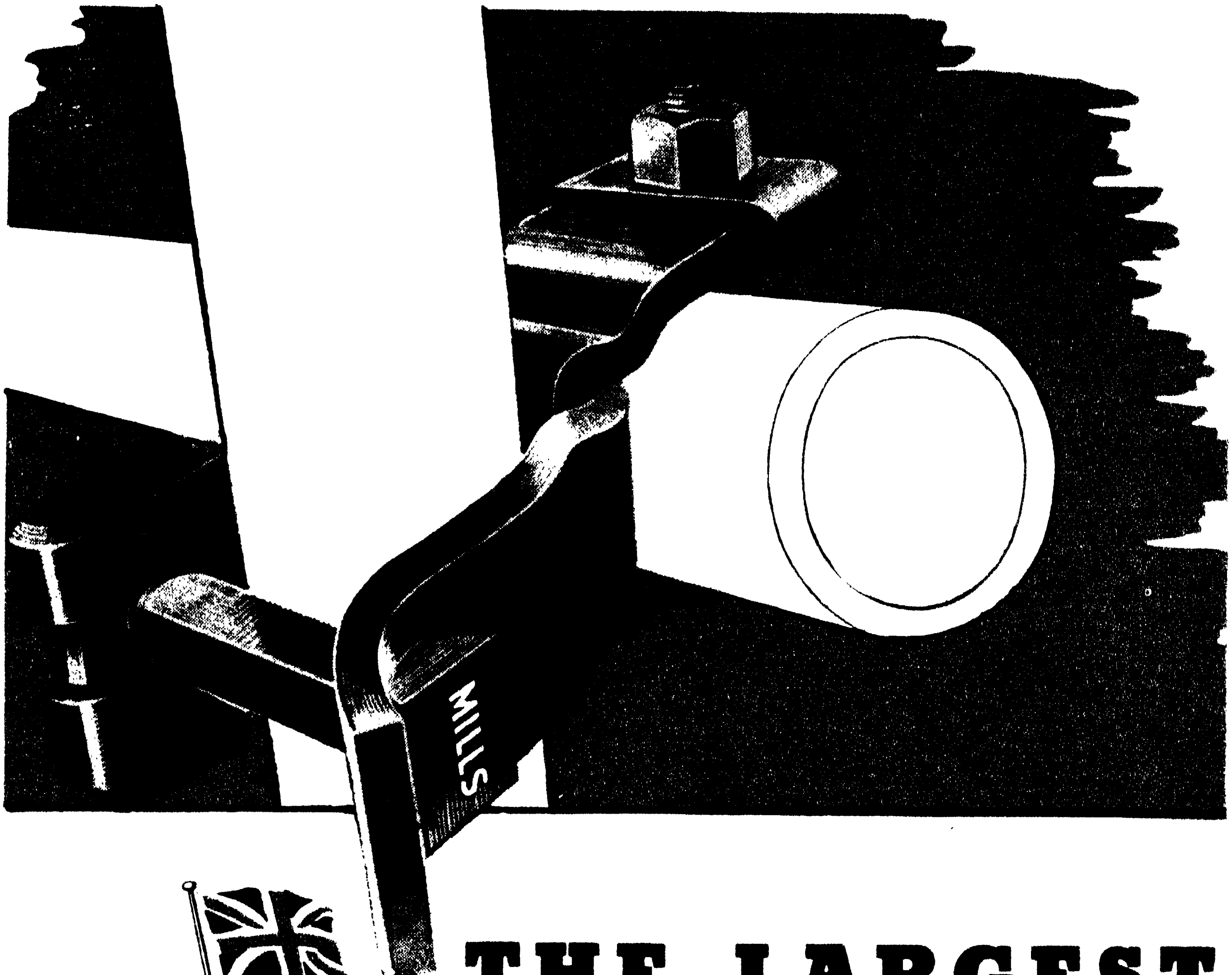
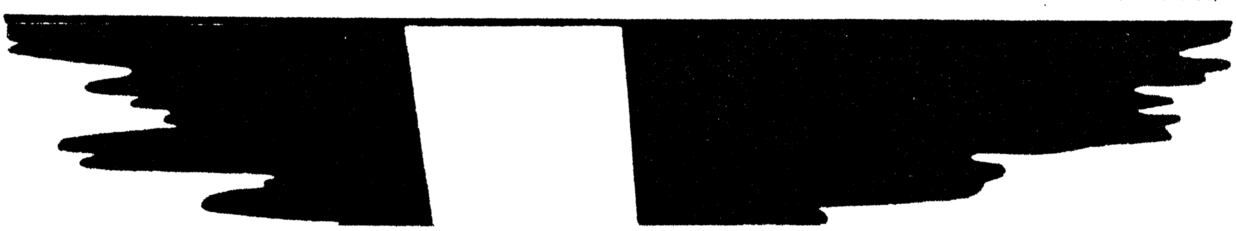
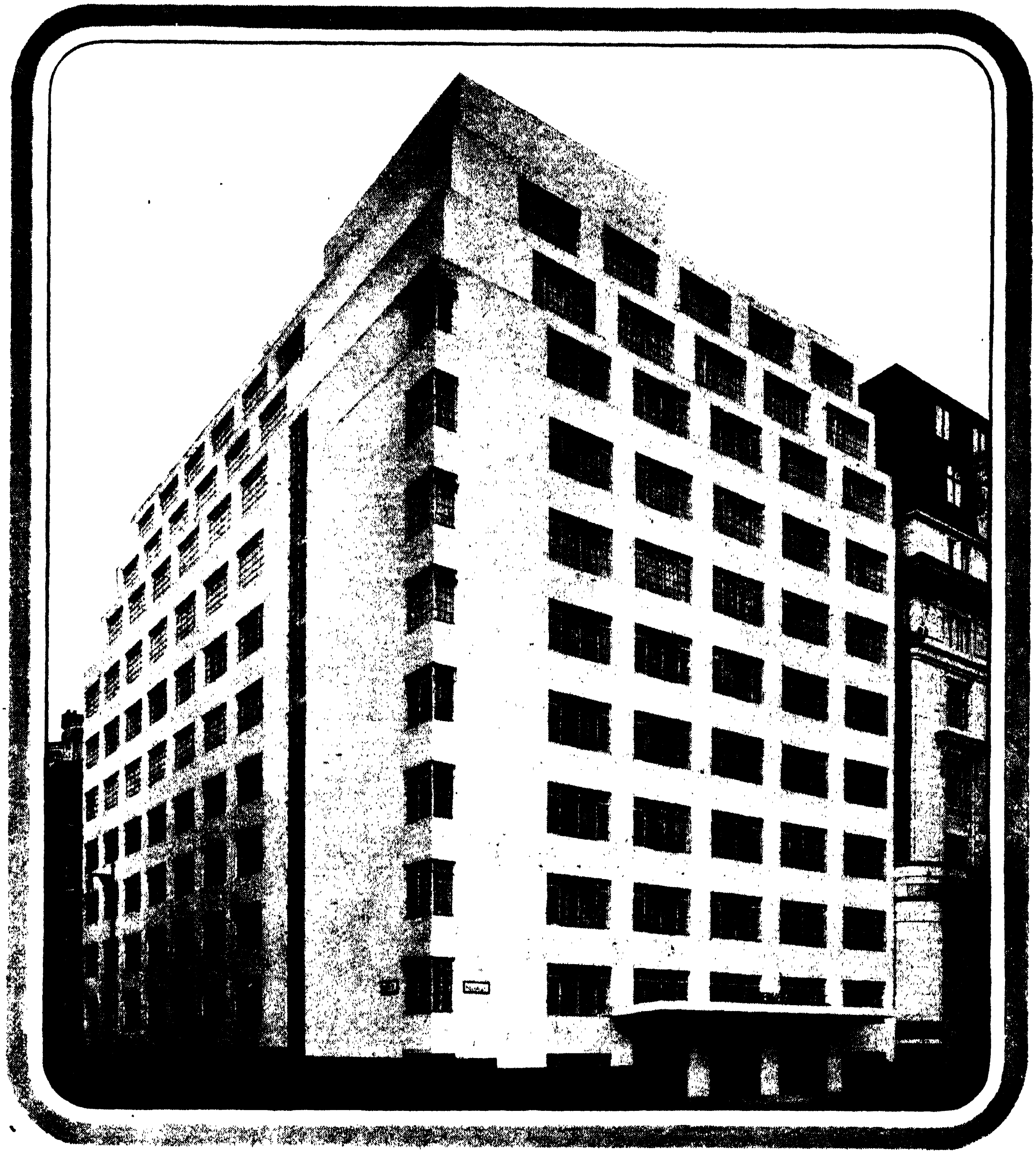

MILLS





Atheneum Court, Piccadilly, London. Architects: Adie, Button & Partners, FF.R.I.B.A.

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Illustration (1): Welded two-hinged arch frame building in course of erection. Span 107 ft., Height 37 ft., Length of building 600 ft. Illustration (2): Sun balconies 35 ft. in diameter supported on welded cantilevers.

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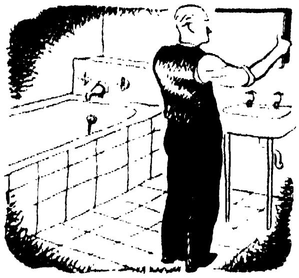
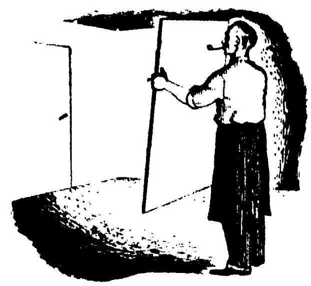
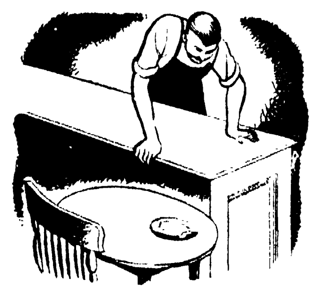


You can save labour on jobs like these by using wall panels, splash-backs, bath panels, table tops, etc., made of WARERITE LAMINATED PLASTICS, shaped and cut to size by Warerite Limited. The material is produced in the form of WARERITE Wall Panels, 5/32″ thick, and WARERITE Veneered Board having a core of plywood, hardboard, blockboard, etc., in maximum sheet sizes of 8 ft. × 4 ft. WARERITE materials have great possibilities for interior fittings and decoration because they combine lightness and strength with an unusually attractive finish. The



range of plain colours is wide and special designs in colour can be incorporated as an integral part of the WARERITE material. Other practical advantages of the material are the ease with which it may be cleaned, its resistance to moisture and its ability to withstand contact with hot teapots, fruit juices, alcohol, etc., which make it a particularly suitable choice for table tops, bars and counters.



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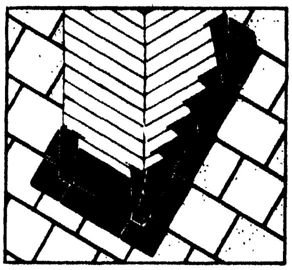
LEAD
Sheet and Pipe

LEAD SHEET

Milled sheet lead for use in building work is available manufactured to British Standard 1178. This Standard provides for milled lead sheet and strip of substance 3, 4, 5, 6, 7 and 8 lbs. per sq. ft. in sheets 8 ft. wide

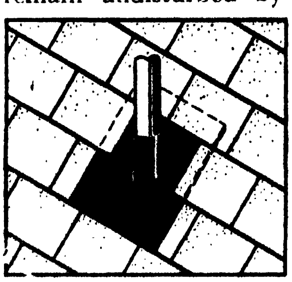


and up to 40 ft. long as required, and strips not less than 3 in. wide. Other substances and sizes of sheet up to 9 ft. width and 60 ft. long are also available. Thicknesses of the various substances of lead sheet are given in the following table:—

Weight in lbs. per sq. ft.	3	4	5	6	7	8
Approx. thickness in inches	0.050	0.067	0.084	0.101	0.118	0.135
Approx. thickness in mm.	1.270	1.702	2.13	2.56	2.99	3.42

In building work the most common uses of sheet

lead are for weatherings, flashings, gutters, roofing, etc., for which it is of basic importance to ensure a long trouble-free life. Sheet lead is capable of outlasting most materials forming the fabric of buildings under normal exposure conditions. The ease with which it can be worked to different shapes makes it pre-eminent for such purposes as flashings to roofs, particularly those of irregular contour, as the material can be worked down into close proximity with the roofing material and will remain undisturbed by any weather conditions.

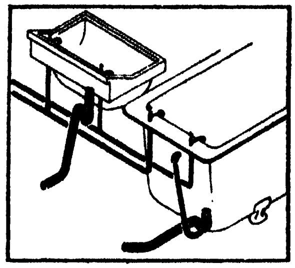


Lead sheet has the advantage of being non-staining; thus unsightly marks on surrounding brickwork or masonry are avoided where lead weatherings are employed.

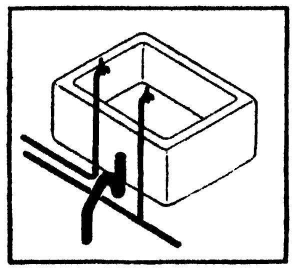
LEAD PIPE

Three types of lead pipe are available for use in building work. These are: ordinary lead pipe, B.N.F. Ternary Alloy No. 2 pipe, and silver/copper lead pipe, which are manufactured to British Standards 602, 603 and 1085 respectively.

MANUFACTURE



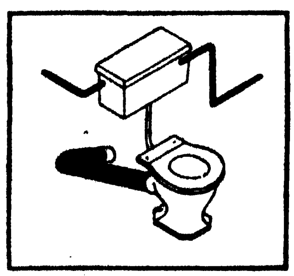
British Standards include provisions for a metal within fine limits of purity, concentricity of bore, absence of extrusion flaws, grain size of metal, etc., and include tables recommending suitable strengths of pipe for various purposes. Lead and lead alloy pipes manufactured to British Standards are also required to bear a continuous marking along the outer surface in order that the standard product may be readily recognised. The alloys



possess a marked increase in tensile strength and creep resistance. over ordinary lead, permitting a reduction in wall thickness, particularly in pipe to be used for conveying water under pressure.

PROPERTIES

The valuable properties of lead pipe, resistance to corrosion, ease of handling and flexibility, are well known and fully appreciated. The alloy pipes have similar corrosion resistance and show little variation in handling and flexibility.



Flexibility in pipe material is of special value in obtaining easy and rapid assembly and fixing of supply, waste and soil pipes. Such flexibility is of even greater importance where off-site preparation methods are applied to plumbing.

LEAD

Detailed information on the use of lead sheet and pipe is given in various Information Sheets and Booklets prepared by the Technical Information Bureau of the Lead Industries Development Council. Copies of these publications are available on application to the address given below. Enquiries for information on specific problems relating to the use of lead pipe should be addressed to the
LEAD TECHNICAL INFORMATION BUREAU,
25 LOWER BELGRAVE ST., S.W.1

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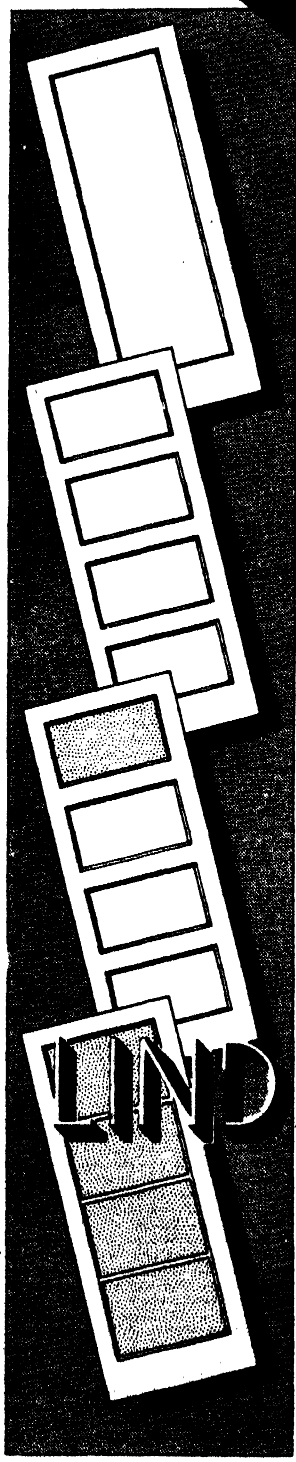
DOORS



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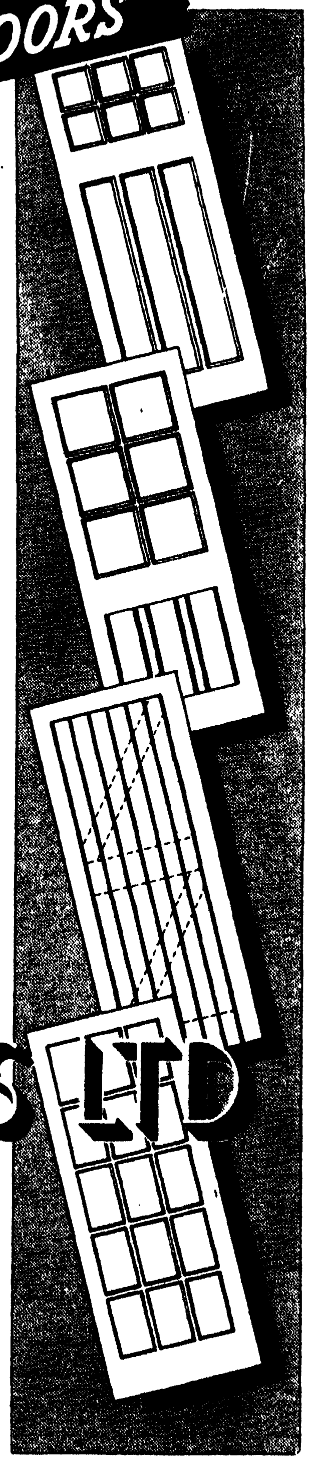

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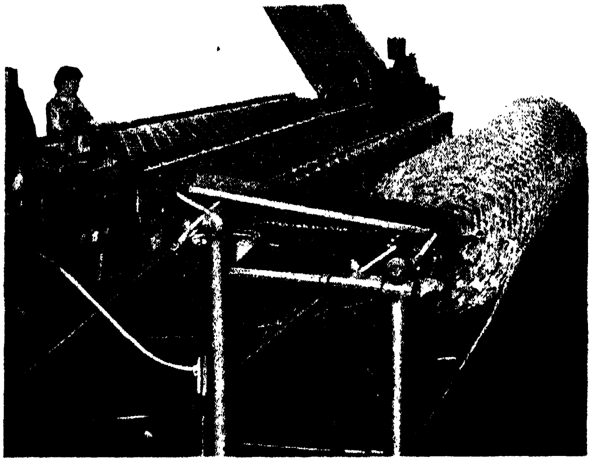

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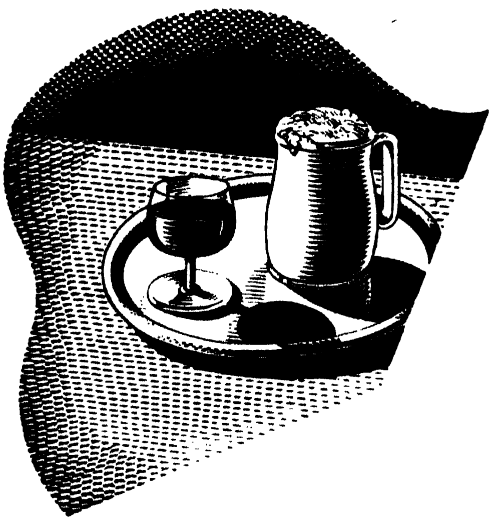

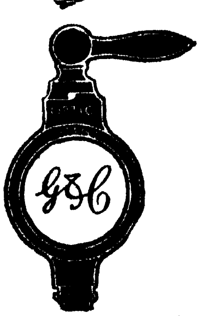
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